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THESIS

GROUP DECISION SUPPORT SYSTEM
TO AID THE PROCESS OF DESIGN
AND MAINTENANCE OF LARGE SCALE SYSTEMS

by

John R. Ross

March 1992

Thesis Advisor: Balasubramaniam Ramesh

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Group Decision Support System To Aid the Process of Design and Maintenance of Large Scale Systems

by

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Lieutenant, United States Navy
B.S., Prairie View A and M University, 1983

Submitted in partial fulfillment
of the requirements for the degree of

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ABSTRACT

This thesis is a continuation of the research done on the REpresentation and MAintenance of Process knowledge (REMAP) project for large scale systems design and maintenance. A review of the REMAP model and the Cooperative Multiple Criteria Group Decision Making (Co-oP) group decision support system will be conducted. These two models complement each other and their combined functionalities will be examined as they relate to capturing and reasoning with process knowledge. This research further explores possibilities of incorporating group decision support mechanisms into the REMAP model. The analytical techniques suitable for supporting cooperative work in systems design activities, as well as the development of a decision support system incorporating them are evaluated.

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I. INTRODUCTION

The system maintenance efforts for large scale systems will benefit immensely if design rationale (i.e. reasons behind design decisions) information from early stages of the lifecycle development is retained. The REMAP project recognized the importance of capturing process knowledge to reason about the consequences of changing conditions and requirements in systems design and maintenance. The most important component of this process knowledge is the knowledge about reasons behind design decisions or design rationales that shape the design (Ramesh and Dhar, 1991). The history of the design process in the form of design deliberations (representing design rationale) can provide vital support to the maintenance effort. If such a representation of the design process, that determined a viable solution for a set of requirements, is maintained in a library, it can be reused in the development and maintenance of similar systems. REpresentation and MAintenance of Process knowledge (REMAP) project has developed a conceptual model as well as mechanisms to capture and reason with the dependencies of design solutions on the design rationale (Ramesh and Dhar, 1992). Requirement's traceability can be provided by relating how a design solution was obtained based on the design decisions and the reasons behind them.

A large project requires an enormous amount of coordination and varied expertise among the team members for successful completion. The design rationale knowledge is important in large projects for the following reasons:

- multi-persons (teams) are involved. Large systems design requires expertise from various disciplines. Viewpoints and expertise of various participants must be correlated, communicated, and analyzed by team members (Curtis et al., 1988).
- current documentation methods are inadequate. A major limitation with current documentation methods is that over the course of time information losses occur as changes over the lifecycle of a project not recorded. Further, they do not contain information about the "why" of design decisions.
- lessons learned are not recorded. The errors encountered in the design process, can be easily identified and avoided in future projects if the design rationale information is available.
- numerous design groups are involved in a large scale project. With several teams working on different portions of the system, accurate design rationales must be disseminated to each group to facilitate coordination and communication (Ramesh and Dhar, 1991).

Large project maintenance tasks are enhanced with process knowledge from the various stages of development. The rationale from early stages of the system development are especially important.

> According to Ramesh and Dhar, Research on Knowledge Based Software Engineering has recognized that the maintenance of software should be done at the level of specifications rather than at the level of code to achieve high quality software. Specifications are the closest in form to the user's conceptual model of the system, the least complex and most localized. Even simple modifications at the specifications level can lead to major changes at the implementation level (Ramesh and Dhar, 1991).

In the group environment of large scale projects, a mechanism to aid in the deliberation process and decision-making is very useful. A group decision support system (GDSS) offers the necessary assistance and gives groups using GDSS software a performance advantage over those who do not use it (Gallupe and DeSanctis, 1990).

In this thesis, the Cooperative Multiple Criteria Group Decision Making (Co-oP) model was chosen to demonstrate the effectiveness of combining a GDSS with REMAP. A case study showing the integration of the process knowledge capturing mechanisms of REMAP and decision making aid mechanisms of (Co-oP) has been developed.

The case study involves a corporation in the information technology field developing a state-of-the-art product to maintain its competitive edge. The case study discusses a hypothetical team of designers analyzing the various alternatives available in designing the system from a fuzzy set of user requirements. The overall objective of the project is to develop a system combining the characteristics of a compact computer (laptop) and a cellular phone. The aim of the company is to better meet the needs of the traveling executive/salesman. This test example, although small in scope, will serve to demonstrate how REMAP and GDSS techniques complement each other in supporting cooperative group decision making.

In chapter II the REMAP model components and functionalities are examined and demonstrated in the test case. Chapter III gives the background and requirements for developing a successful group decision support system and the employment of multiple criteria decision making tools. The components and functionalities of the cooperative multiple criteria group decision making model are presented and illustrated in the test

case. In chapter IV the combined attributes of REMAP and Co-oP are reviewed in relationship to the design of a large scale systems design and maintenance. This chapter concludes with some recommendations for the design of a system to integrate REMAP and a GDSS.

II. REMAP

The Representation and Maintenance of Process knowledge (REMAP) model is designed to support large scale system design and maintenance. The REMAP model includes as a part of it, the Issue Based Information Systems (IBIS) method, a model of the argumentation process. The REMAP model aims at capturing and maintaining design rationales from the early stages of lifecycle development. Design rationales refer to the reasoning and logic justifying the choices made in the design process.

> Ramesh and Dhar stated, Though the original IBIS method has been found to be suitable for capturing conversations in a wide variety of contexts, it does not provide primitives to relate the process knowledge to the artifacts that result from the process. Tools such as gIBIS and IBE are constrained by this overly passive nature of the IBIS, and do not address the need for some intelligent decision support capability in order to make use of the knowledge captured during design deliberations. Our extended-IBIS model provides primitives necessary to represent various knowledge components involved in the process design (i.e., the task of transforming initial requirements into design objects during the design deliberation process) resulting in an environment that better support design and maintenance tasks (Ramesh and Dhar, 1991).

The REMAP model provides the basis for mapping informal design specifications to the design solutions through design rationale. This model focuses on capturing the design deliberation process and supports various systems development activities. One of the biggest problems in software maintenance and support functions is the lack of documentation from earlier lifecycle processes (Ramesh and Dhar, 1992). Information from the implementation phase is usually available but the data from initial dialectic discussions that led to his output are typically unavailable. The very nature of decisions

made in systems development activities requires expertise from various disciplines which can best be obtained through a group consortium (Seybold, 1987).

> This is supported by Ramesh and Dhar who stated, As these projects involve often large and complex problems, creation of design solutions involves knowledge that spans several areas including the application domain, system architecture, machine architecture, and algorithm structure. As no single designer possesses all the knowledge required to produce a solution, a team of several members is typically involved in a design task. Software design is essentially a cooperative task and requires information exchange that distributes various relevant components of knowledge among the group members. Further,the task involves resolution of underlying incompatibilities among mental models of individual team members to achieve a consensus view necessary for productive work (Ramesh and Dhar, 1991).

One of the objectives of REMAP is to provide a framework in which design rationales are used in developing a system. By expanding the IBIS model, REMAP records deliberations as argumentation. The principal advantage of this model is its ability to relate a solution to the design rationale that led to its creation. Mapping a solution back to its initial requirement specifications or tracing alternatives to their resulting outcome is very helpful. Maintenance support for large project's design is enhanced by the abilitity to evaluate design rationales used in development and choose the best among the alternatives. Further, the process knowledge offers the maintenance personnel the ability to better diagnose errors and take corrective action. Such a support mechanism greatly reduces the time required to troubleshoot and identify possible problem areas. Another application for the mapping mechanism is providing assistance in the initial design phase to evaluate the various choices. With the magnitude of possibilities available, a tool to trace each alternative to its outcome promotes a higher

quality analysis. The task of eliminating alternatives to arrive at the best selection based on the criteria becomes easier with the use of decision support tools.

REMAP identified the following as components of a conceptual model describing the process of generation of design solutions from requirements:

- requirements: A capacity needed by a user to solve a problem or achieve an objective. A capability that must be met or possessed by a system or system component to satisfy a contract, standard, specification, or other formally imposed document. The set of all requirements that form the basis for subsequent development of the software or software component.

- design components that are put together to form design solutions that satisfy requirements.

- design rationale, representing the elaboration, refinement and modification of requirements, leading to decisions.

- design decisions that define constraints to satisfy requirements.

- application domain specific design components that are put together to form design solutions that satisfy the constraints.

The above components and the relationships among them are shown in the conceptual model in appendix A. The segment contained in the dotted line identifies the IBIS primitives.

As requirements or assumptions change, the decisions made during the requirement phase become a vital part of the overall system maintenance effort. Most modification efforts typically do not involve the original designers and are generally done by a different group of decision makers. It is extremely helpful if the new group's members have the past knowledge available to evaluate and expound upon. Knowledge about prior design decisions helps in reviewing original specifications for completeness and for their

potential use in the current design task. Depending on their design objective, the decision makers can either support the previous logic or form a different rationale tailored to their needs. The components used to represent the capture of design rationale are issues, positions, arguments, and assumptions.

- issues are the questions or concerns considered by the designers to satisfy the requirements.
- positions respond to issues raised in the deliberation process.
- arguments either support or object to positions.
- assumptions qualify arguments.

A network consisting of issues, positions, arguments, and assumptions comprise the deliberation process. REMAP explicitly represents goals that drive the argumentation process in the form of requirements. The user requirements represent the goals to be satisfied by the design deliberations. In the deliberation process, initial requirements may be modified or refined to generate sets of sub-goals or other issues which explicitly represent a decision. Requirements can also be modified by the resolution of issues, which by their evolving nature can change the characteristics of the design (Ramesh and Dhar, 1992).

> According to Ramesh and Dhar, Resolution of an issue (or set of issues) during the design process (by making decisions) may also lead to modified requirements, characterizing the evoking nature of the design process (Ramesh and Dhar, 1991).

The ability to map a decision back to its defining requirement, issues, and assumptions provide the foundation for reuse. A library of the resolved issues and their solution path can provide a basis for the development of follow-on applications. This

data on the resolved issues and the deliberation process allows the reuse of reasoning behind critical decisions in new applications reducing the amount of duplication in effort.

Another aspect of capturing process knowledge concentrates on the area of constraints upon the design. Constraints are created when positions are chosen to resolve issues. During the deliberation process, a set of alternatives is established to resolve a design issue. The REMAP environment architecture ensures the constraints are met as the requirements and assumptions change. REMAP environment facilitates the acquisition, maintenance and use of process knowledge in large scale design tasks. The design tasks are supported by an environment composed of five modules: 1) Application domain knowledge acquisition and reasoning module; 2) Design rationale knowledge acquisition and reasoning module; 3) Design methodology knowledge acquisition and reasoning module; 4) Design synthesis module; 5) Reason maintenance module. The environment diagram is provided in appendix B. REMAP provides mechanisms to instantiate, query, and modify instances from design deliberations interactively, thereby facilitating the incremental acquisition of process knowledge.

A test case (cell_comp_design) involving the design of a product is used to demonstrate the REMAP functions. The problem consists of designing a new product that combines the characteristics of a cellular phone and those of a portable computer (laptop). This product must provide the user easy transportability and the convience of office support equipment while travelling. The task of the project team is to decide which functional capabilities are to be included. The term of functional capabilities in this context refers to the following alternatives: Interface capability between existing systems

of cellular phones and laptops; maintainability of a new product with changing technology; ability of the system to provide network services; and the ability to produce hardcopy data from geographically distributed systems. The functionalities include system_interface, maintainability, networking, and fax. Further, the project team will also have to decide whether the system will be built in-house or use off-the-shelf products. The principles outlined in this small test case can be directly applied to large scale system design and maintenance.

The hypothetical test case (cell_comp_design) illustrates hypothetical discussions among a group of system developers. A group of designers, from various backgrounds could pool their talents to resolve the issues (problems) through the lifecycle development phases. The lifecycle phases consist of systems requirement analysis and planning, design, construction and testing, implementation, operation and maintenance, and evaluation and control. The issues discussed in this case are the functional design requirement and design method to be used in the design of the new product. The REMAP output of the discussion is provided in appendix C.

A decision explicitly represents the resolution of one or more issues (Ramesh and Dhar, 1992). This REMAP relationship allows decision makers the ability to analyze alternate designs based on different evaluation criteria. The modeling of assumptions made in the deliberation phase allows for mechanisms to evaluate the applicability of arguments and their supporting position. The test case model under consideration in this thesis provides examples of each REMAP component. The first issue to be resolved is the functional-design of the new product. The next issue for design consideration is

whether the software to be used will be developed in-house or purchased off-the-shelf. Only the first issue will be examined using REMAP. Systems-interface, maintainability, Network, and FAX are the positions that responds to the functional-design requirement (issue). The corresponding arguments which in this case supports the positions are as follows:

- Large Inventory to System-interface
- Changing Technology to Maintainability
- Network Applications to Network
- Hardcopy to FAX

The argument "changing technology" objects to the position "system-interface" because it supports follow-on maintenance efforts. A large inventory of existing systems is the argument supporting compatibility with existing systems. However, an assumption behind this argument is that the existing systems are made up of standard components that could be integrated into the new system. The REMAP output highlighting this situation is in appendix D. REMAP helps structure the problem and identify the alternates from the deliberation process. This information is used in the REMAP model to determine if an alternative is valid. If the alternative system interface was invalid because the components could not be standardized, it would be voided from the list of possible options. REMAP automatically propagates the effect of changes in the belief status of assumptions linked to arguments and positions. The invalidation of the position would remain in effect until the belief in the assumption remains the same. When the assumption that the existing components are made of standard parts is invalid, the positions to be

considered are maintainability, network, and fax. Appendix E shows that if the assumption (standard components) is invalid, the argument it supports (large inventory) and hence the position (system-interface) will become invalid. Once the alternatives have been identified, they must be analyzed in accordance with the design objective. The team identified the following criteria to choose from among the alternatives: compatibility, usability, cost, efficiency, and reusability. Now that several alternatives will be evaluated with only one to be chosen for the final solution based on these criteria, a GDSS can greatly aid this task. The group decision support system model provides various tools to help in the selection of an alternative. The next chapter reviews group decision support systems, specifically focusing on those that support decision making models. The Co-op model will be examined to demonstrate the applicability of GDSS techniques in the example.

III. GDSS FOR MULTIPLE CRITERIA DECISION MAKING

Interactive computer-based decision support systems evolved from the introduction of interactive computing. Interactive computing along with more powerful and compact operating systems, allows for real time data retrieval, multiple simultaneous access, and decision modeling techniques to be employed by decision makers. As a result, decision support systems were developed to aid the decision maker in the problem solving task. A decision support system includes the summation of all related data, information exchange, human intellect and intuition, and computer resources that contribute to the decision choice (Andriole, 1989). It is important to remember that the computer supports the decision of the decision makers' reasoning capability and does not replace it.

> Sage, Goicoechea, and Aiken stated, In general terms, a decision support system (DSS) is a computer-base system that supports managerial decision making by assisting in the organization of knowledge about ill-structured problems (Sage and et al., 1987).

Decision support technology aims to support the decision making process by, among other things, reducing the cognitive load, or mental effort associated with group meetings. Group decision support systems (GDSS) combine computer communications, and decision technologies to support problem finding, and formulate a solution in group meetings. Groups use computer power to obtain and correlate vast amounts of information or data resources.

> According to Phillips, Better decisions taken in a shorter time can be achieved by using computers in a new way that helps groups of people who are working on major issues of concern to an organization. This approach helps people to develop

fresh insights into a problem, generates a shared understanding of the issues within a group, and creates a sense of common purpose (Phillips, 1987).

Information resources play a major role in an organization's effectiveness. These provide a qualitative, timely, and efficient way to manage business information economically (Thierauf, 1989). Computer technology has allowed more organizational resource data to be collected and rapidly assimilated in a manageable fashion. The man-machine interface is essential to this process because the users must feel comfortable and uninhibited in performing their tasks. An environment that complements the decision makers ability to solve problems and doesn't interfere with their thought process is an effective use of computer resources. Group decision support systems are designed to augment the decision maker's capabilities and serve as an extension of their mind-set (by providing increased data storage capacity and advanced logical reasoning skills).

The vast and dynamic nature of today's business environment leads to more complex and high risk problems that must be resolved. In most situations, the magnitude and scope of the analysis needed to provide a formidable decision requires the sharing of expertise from various disciplines (Thierfauf, 1989).

> According to Thierauf, Due to rapidly decreasing costs of computer storage and improvements in data entry and database management systems, it is increasingly likely that much or all of the information managers need for reaching a decision can be stored on-line in the database, thereby making GDSS a logical tool for analysis and problem solving (Thierauf, 1989).

An effective GDSS provides what-if analysis as well as evaluating possible alternatives and problem seeking mechanisms. What-if analysis refers to the probing technique to determine an outcome if a particular act is carried through. Problem seeking

mechanisms conduct thorough examinations of system/design objects to detect any existing or probable future errors or malfunctions. What-if types of questioning aids in the problem identification and points out key conflicts to be resolved or avoided. The selection of the best alternative must be based on an elimination process of other possible choices.

GDSS tools provide evaluating and voting mechanisms and in some cases negotiating modules enhance the decision matrix properties. Decision matrix refers to the cause and effect diagram that weighs the possible alternatives to the constraints to achieve a solution. The ability to foresee future problems or trends can greatly effect the current decision foundation, therefore care must be taken in the decision process to support the long term objectives and goals. The purpose of GDSS is to facilitate information exchange for effective group performance, by applying greater degrees of change to the communication process, while invoking deliberations with a more dramatic impact on the decision process and results (Thierauf, 1989).

Another area regarding GDSS usage is the question of individual decision-making and risk compared to that of a group. This research will not explore this point because the design issue to be resolved typically involves a group effort. A more detail review of group versus individual decision making can be found in the research of Thierauf. However, caution must be used to avoid the phenomena of group think, where pressures from the majority lead the minority to conformity on issues that obviously pose problems.

The framework for a successful GDSS includes the following elements:

- effective information exchange and participation among group members.
- integration of physical proximity and cohesiveness of group members.
- balanced approach to power and influence by group members.
- proper balance between decision quality and group satisfaction,

according to Thierauf.

GDSS combines the computer's capabilities and user's mind in the production of meaningful information to support final decisions. Presently, GDSS are defined as seeking and supporting alternatives, deliberation, information exchange, consensus building, negotiation, as well as allowing decision making for group members not in physical proximinity at the same time (Vogel, 1988). GDSS has addressed issues of group dynamics as the actual effectiveness of the group equals its potential effectiveness less its process losses plus the process gains obtained. The potential effectiveness refers to the effectiveness of the group when they achieve their objective in the problem solving task. Process losses in this context mean the missed opportunities of group members to fully participate or dominance by a group member forcing conformity and compliance to their views. Process gains occur when a contribution to the decision quality is obtained by virtue of a member coming up with a new and useful idea that was stimulated by the comments of another member (Vogel, 1988). It was suggested that the key to success rests in the following: 1) facilities that provide a professional setting in which sophisticated software and hardware is well organized and effectively supported, 2) ability to accommodate groups of sufficient size that may vary considerably in composition and experience and who address tasks that are real and complex by nature, and 3) facilitation that demonstrates technical competence in combination with an appreciation for group

dynamics with a research orientation that encompasses a multi-disciplinary approach (Vogel, 1988).

This research is concerned with the multiple criteria decision-making aspect of GDSS. As discussed earlier, large scale systems development requires participation of stakeholders with varied expertise and viewpoints. In large scale systems design, a group is required to analyze the possible options and establish a viable outcome. GDSS provides techniques which can aid this process. GDSS utilizes various tools of multiple-criteria decision making to enhance the decision makers capabilities.

> Rajkovic, Bohanec and Efstathiou stated, Multi-Attribute Decision Making (MADM) describe options according to a chosen set of a attributes (parameters, criteria). Each option is decomposed and represented by corresponding values of attributes. Usually, attributes are evaluated separately. A final option value (overall utility) is then obtained by a kind of aggregation formula, e.g. weighted sum of individual attribute values. The overall utility, which is usually numerical, provides a basis for ranking options and the final decision (Rajkovic, Bohanec and Efstathiou, 1987).

MCDM incorporates various methods which represent radically different approaches to solving problems. The mere fact that MCDM methods must be flexible for analyzing a wide range of problems and include the preferences of the user, make their design complex. The variety of assumptions about the decision makers preferences make classifying and evaluating MCDMs difficult (Ozernoy, 1986). Ozernoy developed a framework for choosing the most appropriate discrete alternative multiple criteria decision making method. This framework consists of five major components, namely: 1) characteristics of different decision situations, 2) an extensive list of available MCDM discrete alternative methods, 3) screening criteria and their criteria scales that can be used

to eliminate those MCDM methods inappropriate in a particular decision situation, 4) evaluation criteria and their corresponding criteria scales which can be used to compare the resulting MCDM methods not eliminated by the screening criteria, and 5) a procedure for determining the MCDM method(s) most appropriate for the user in a given decision situation (Ozernoy, 1986). This framework allows for only quantified MCDM methods to be used for a problem (decision situation) to obtain the best performance in the solution. In his technique, Ozernoy defined the character of the decision situation in the following categories:

1) Characteristics of the decision problem

- Type of the decision problem
- Flexibility of the statement to the problem
- Number of alternatives to be evaluated
- Number of criteria to be considered

2) Characteristics of the decision maker

- Assumptions about the decision maker's preference
- Most valid kind of preference information
- Completeness of preference information
- Importance of the problem to the decision maker
- Decision maker's interest in sensitivity analysis

3) Resource constraints

- Time pressure of the study
- The amount of time the decision maker has available
- Cost constraints

Upon clearly defining the decision situation, the next step is to determine the objectives the MCDM must meet. The hierarchy of objectives to be achieved by MCDM methods consist of 1) ensuring MCDM method chosen is well suited for the decision

situation, 2) compatibility between the decision makers' preference and the preference information available, and 3) demand for resources of the MCDM method selected are within it's scope (Ozernoy, 1986). It is imperative that these objectives be met in order to ensure the success (e.g.,user satisfaction) of the MCDM method used. The steps outlined in this framework are to define and quantify the decision situation, employ criteria screening mechanisms to eliminate MCDM methods that are not suitable for the task, selection of a method from feasible alternatives, and if a feasible MCDM method (for the decision situation) does not exist then either develop a new method or revise the problem statement (if allowable) to obtain partial ordering of a set of feasible alternatives from which to select (Ozernoy, 1986). An MCDM is composed of several phases to achieve its desired objectives. Rajkovic, Bohanec and Efstathiou, have suggested that the various phases of MCDM process include: 1) Forming a decision making group, 2) Identification of options (goals, issues, levels of resolution), 3) Identification of attributes, 4) Decision-knowledge acquisition, 5) Analysis and evaluation of options, 6) Explanation of results, and 7) Implementation of a decision (Rajkovic, Bohanec, and Efstathiou, 1987).

The phases are flexible and can be used interactively to achieve the best solution. In some cases several passes through the phases may be required to decompose the problem enough to meet the objective. It is important to note that none of the phases should be omitted, because their systematic knowledge acquisition and process reduce the possibility of overlooking important pieces of information (Rajkovic, Bohanec, and Efstathiou, 1987). One important aspect that both approaches did not mention is the identification of

assumptions. It is very important to consider the effects of assumptions when they keep evolving as they do in system development efforts.

This research is concerned with supporting a cooperative environment for decision making. In such an environment, decision makers tend to obtain a common solution by means of friendly trusting dialogue, and full participation by each member to share the responsibility of the decision (Bui, 1987). Therefore, the cooperative multiple criteria group decision making GDSS was chosen for this research.

A collective decision making process can be defined as a decision situation in which 1) there are two or more persons, each them characterized by his or her own perceptions, attitudes, motivations, and personalities 2) who recognize the existence of a common problem 3) attempt to reach a collective decision (Bui and Jarke, 1984). The MCDM tools provided in this environment will be used in this research.

The Cooperative Multiple Criteria Group Decision Making model (Co-oP) was used in conjunction with REMAP to support large scale systems maintenance. The Co-oP system supports the following decision situations:

- cases where there or two or more users who are assigned weights (equal or unequal) or 'hierarchically' distributed based on the decision making context or member's expertise;
- a common set of feasible decision alternatives that can be generated and collectively accepted by group members;

- each decision maker has his personal objectives that reflect a priori values and aspiration levels. Objectives are concretely expressed by criteria or attributes that are discrete, and at least ordinally measurable;
- the members can be geographically separated;
- when a consensus is not found, negotiable alternatives are sought -if any- to offer members new perspectives for further analyses (Bui, 1987).

Co-oP uses process-oriented MCDM methods in its problem solving techniques. A process-oriented method is one where the group follows a methodological approach, going through certain phases to achieve the final decision. The main menu gives the following choices:

1) Group Problem Definition - This selection allows the group leader or facilitator to input the problem statement, alternatives, evaluation criteria by hierarchy, education and experience levels of members, and their area of specialization.

2) Group Norm Definition - Allows the group chairman to input group members, each member sets his own password, decision techniques and information exchange procedures. These are also outlined on the menu screen under group norms.

3) Individual Prioritization of Evaluation Criteria - Group members prioritize their evaluation criteria directly using ELECTRE, or by using the Analytical Hierarchy Process (AHP) for hierarchical prioritization.

4) Individual Evaluation and Selection of Alternatives - Allows the decision maker to individually evaluate alternatives using his preferred or familiar MCDM.

5) Direct Input of Individual Evaluation - member can by pass steps 3 and 4 if he has a clear-cut opinion as to what alternatives are to be chosen or ranked by direct unaided input of individual solutions.

6) Computation of Group Decision - Computes group results using the appropriate one out of four preference techniques.

7) Identification of Negotiable Alternatives - Allows for a consensus seeking algorithm to be evoked if unanimity is not obtained.

The ELECTRE method circumvents the problem of incomplete comparability of alternatives through its concept of outranking relations. The AHP method supports complex decision problems by successively decomposing and synthesizing various elements of a decision situation. Both AHP and ELECTRE permit subjective and qualitative pairwise comparison of alternatives. AHP also uses the concept of priority 'level of strengths' of one alternative relative to another. Co-oP can support aggregation of preference and consensus analyses. This GDSS process can be applied to almost any multiple criteria group decision making situation. Co-op's architecture is flexible to allow tailoring to the groups needs. In the analyses phase Co-op enriches the deliberation and group consensus processes. If a consensus is not reached then the process of negotiation must be entered to resolve the conflict. In considering the process of negotiation, Cats-Baril classified issues by the nature of the disagreements behind them (ideological vs. technical), and classified the levels of resolution by their acceptability and effectiveness as perceived by the different stakeholders (Cats-Baril, 1987). The NAI negotiating model

is incorporated in the Co-oP GDSS and its functions are illustrated in the cell_comp_design case.

Co-oP was used in the cell-comp-design case to illustrate its functionalities in resolving the issue on functionalities to be implemented. Cell-comp-design was aimed at reaching a portion of the market by expanding existing systems. The decision makers' reasoning behind this choice was that they wanted to offer services that are already in existence but not linked together. Thus the consensus was to use existing technology with a goal of marrying the to systems (cellular phone and computer) for enhanced user benefits.

The position of system-interface supports the primary functional specification of the cell-comp-design if compatibility to existing systems is important. A change in argument to one of implementing leading edge technology and state of the art product line (changing technology) would tend to support the position of maintainability.

The case, in this instance, examined the analysis of the initial design objective by a different set of decision-makers to arrive at a consensus. Each decision-maker was required to review the same set of alternatives and criteria established by the initial design team. The hypothetical group of decision makers is composed of four information technology experts The decision makers will be referred to as DM ONE, DM TWO, DM THREE, and DM FOUR. The inputs by the group's decision makers and the Co-op computations are in appendix F.

At the start of each run, Co-op allows the user to review a predefined problem or norm. In cell-comp-design, each member was given equal weight and the ability to

evaluate alternatives according to all criteria. Automatic computation of NAI (negotiating mechanism) and the broadcasting of individual outputs were incorporated. These norms are flexible and can be tailored to meet the needs of any group. Each group member was allowed four revisions of his/her analysis after the group analysis is computed. This is important in the event that a consensus is not reached. Each decision maker could prioritize the evaluation criteria, by either the AHP or Direct methods. DM ONE and DM THREE used the AHP method for assistance in the prioritizing, where as DM TWO and DM FOUR used the Direct method.

In evaluating the alternatives, a solution can be achieved for each individual, by their selection of either AHP, ELECTRE, or DIRECT methods. For the cell-comp-design case DM ONE used the ELECTRE method which includes concordance, disconcordance, and outranking matrices. ELECTRE also applies threshold values between [0-100] for concordance (P) and disconcordance (Q). These values for DM ONE were set at P=80 and Q=65. DM TWO used the AHP method for hierarchial method of evaluation. DM THREE and DM FOUR chose the DIRECT method for their input because they were sure of their preferences. To illustrate the direct input of alternative weights option, DM FOUR directly applied his values.

After prioritizing criteria and evaluation of alternatives is completed by all group members the group decision can be computed. If a consensus solution is not reached, the negotiating option can be invoked to identify problem areas for consideration and possible re-evaluation by the group. The results of this group's overall analysis, with the aid of Co-op, supported the alternative of "system-interface" for the functional design

specification. If the solution was to change from the initial design groups selection of system-interface, then it would support the concept of reuse for follow-on applications. The second group did not have to re-engineer the formalization of the problem from fuzzy specifications, but merely reuse the data and process knowledge of the initial designers.

IV. PROCESS KNOWLEDGE IN A GDSS FOR LARGE SCALE SYSTEMS

Designing a GDSS for large scale systems maintenance requires the incorporation of the ability to capture process knowledge covered in chapter II, and use of MCDM methods from chapter III. To date, most of the research done on GDSS is categorized as either efforts that support communication aspects of the group, or which provide analytical support for group decision makers. Most systems that employ MCDM methods assume that the alternatives, issues, and decision criteria are well defined and agreed upon (Ramesh and Dhar, 1992). In large projects, the decision situation is complex, therefore the very task of identifying the problem statement, issues, and decision criteria, from a set of unstructured and unclear requirements, can lead to finding a solution. In addition to providing information exchange and structure, REMAP provides reasoning behind the argumentation and deliberation processes. These attributes of REMAP are to be complemented with a GDSS to support large scale systems development. The approach proposed in this thesis is based on the proposal by Ramesh and Dhar (Ramesh and Dhar, 1992).

REMAP captures the process knowledge from the decision makers deliberations and stores it for reuse. In some cases, there can be only one valid choice or alternative making the selection apparent. This is rarely the case in large projects. This research utilizes MCDM methods to aid decision makers in handling multiple alternatives and criteria. REMAP uses a reason maintenance system to maintain reasoning about explicitly

identified dependencies. The dependency network (deductive rules defined over instances or object classes) maps assumptions to arguments, and then to positions (Ramesh and Dhar, 1991). The GDSS design is further enhanced with these functions included in it. The decision maker, using this GDSS, can now finalize incomplete requirements into formal specifications, capture the information from the design process, and store this knowledge along with its reasoning for reuse. The next major objective in this research is to ensure that support from MCDM methods are incorporated.

MCDM methods are incorporated to aid the decision maker in choosing from a set of viable alternatives. These methods can include voting and ranking mechanisms, statistical or mathematical modeling, etc. The structural layout of Co-oP adequately illustrates the basis for incorporating MCDM methods in this design. The AHP and ELECTRE methods illustrated by Co-oP enable decision makers with un-refined preferences to select an alternative that suits their objective. Co-oP also gives each group member the option of employing a MCDM or directly imputing their data. A partial listing of some representative MCDM methods for discrete alternatives decision problems include: weighing methods, multi-attribute utility theory, measurable value theory, analytical hierarchical process (AHP), weighted-additive evaluation function with partial information, multi-attribute method with incomplete information, pairwise comparison of alternatives with ordinal criteria, simple multi-attribute utility method, and ELECTRE I, II, III (Ozernoy, 1986). The flexibility to allow decision makers to utilize an MCDM method of their choice is included in Co-oP and will be valuable in the context of systems design.

The cell-comp-design case demonstrated how REMAP and Co-oP enhance information exchange among group members. This group communication is imperative because the wealth of knowledge in a group is superior to that of the individual (Maier, 1967). Additionally, the performance level of groups using GDSS software had a distinctive advantage (decision quality, speed, confidence, and satisfaction) over those groups who did not use GDSS in the problem solving task (Gallupe and DeSanctis, 1990). The environment/culture and system interface must not be inhibiting, the setting must be comfortable and flexible for a system to be effective. Ability to accommodate the performance skill level of the user (novice to expert computer user) is an example of such a feature.

Additionally, the argumentation phase of the group decision making will be supported and documented by REMAP.

> According to Schwenk and Huff, Argumentation within a group of individuals is often prescribed as an effective technique for encouraging the development of rationale and comprehensive decision processes and reducing the effects of biases... One assumption related to the use of strategic decision making aids is that biases may exist due to human information processing limitations (Schwenk and Huff, 1986).

The GDSS design in this research prohibits dominance by one group member and aims to avoid the forcing of compliance to a view by anybody. This protection mechanism from influential pressure is important because of the impact of the group consensus relative to the changed position. When conflicting views are encountered, the decision is optimized if the least constructive ideas are induced to change, however, if the person with most constructive views change the end-product is degraded (Maier, 1967).

These design issues discussed from a GDSS viewpoint adequately handle the requirements of large scale system maintenance and design. Large projects are unique in the amount of expertise required to resolve the issues.

This research has provided a framework for successfully developing a GDSS for large scale systems maintenance. The purpose of GDSS should be to match the organizational goals. A listing of the major guidelines for a GDSS to support system development activities include:

- problem-centered design not computer-centered
- support for process-oriented information capture and exchange
- flexibility to meet the needs of group dynamics
- smooth transparent operations, so as not to impede group member's performance
- availability of various multiple criteria decision making models for support (Phillips, 1987).

REMAP provided the ability to capture process knowledge while Co-oP assisted the decision maker in achieving a solution. These capabilities provide mechanisms required in the development and maintenance of large scale systems. Using a GDSS incorporating REMAP and Co-oP functionalities in the design and development of large scale system, enables the time and effort spent to be reduced, the decision quality and overall satisfaction among group members to be increased, and the sharing of information to be expanded.

Recommendations for further study would be to examine applications of Computer Aided Software Engineering (CASE) tools into the enhanced REMAP environment. Additionally, techniques for (machine) learning from knowledge captured from design deliberations can be developed to aid the development of similar systems.

LIST OF REFERENCES

Andriole, S.J., Handbook of Decision Support Systems, TAB Books INC, Blue Ridge Summit, PA, 1989.

Bui, T.X., "Co-oP: A Group decision support system for cooperative multiple Criteria group decision making", Lecture Notes in Computer Science 290, edited by G. Good and J. Hartmanis, Springer-Verlag, N.Y., 1987.

Bui, T.X. and M. Jarke, "Communications requirements for group decision support systems," In Proceedings of the Nineteenth Hawaii International Conference on Systems Sciences, Honolulu, HI, 1986, N.p., 1986.

Cats-Baril, W.L., "A methodology for decision support in conflict analysis," Effective Decision Support Systems, edited by J. Hawgood and P. Humphreys, Technical Press, Brookfield, VT, (1987): pp. 143-175.

Curtis, B., H.Krasner, and N. Iscoe, " A field study of the software design process for large systems," Communication of the ACM, Vol. 31, November 1988.

DeSanctis, G., and R.B. Gallupe, "A Foundation for the study of group support systems," Management Science 33, no. 5 (May, 1987): pp. 589-609.

Maier, N.R.F., "Assets and liabilities in group problem solving: The Need for an integrative function," Psychological Review 74, no.4 (July 1967): pp. 239-249.

Ozernoy, V.M., "A framework for choosing the most appropriate discrete alternative multiple decision-making method in decision support systems and expert systems," Lecture Notes In Economics and Mathematical Systems 286, Vol 2., edited by M. Beckmann and W. Krelle, Springer-Verlag, N.Y., (1986): pp. 56-64.

Phillips, L.D., "Conferencing to Consensus" Effective Decision Support Systems, edited by J. Hawgood and P. Humphreys, Technical Press, Brookfield, VT, (1987): pp. 176-183.

Ramesh, B., and V. Dhar, "Group support and change propagation in requirements engineering," in Development Assistance for Interactive Database Applications edited by M. Jarke, Heidelberg, Germany: Springer Verlag, 1991.

Ramesh, B., and V. Dhar, Representation and Maintenance of Process Knowledge for Large Scale Systems Design and Maintenance, IEEE Expert, 1992 (To Appear).

Ramesh, B., and V. Dhar, Role of Process Knowledge In Group Decision Support, Working Paper, Department of Information Systems, New York University, N.Y., January 1992.

Ramesh, B., and V. Dhar, Supporting Systems Development Using Knowledge Captured During Requirements Engineering, IEEE Transactions on Software Engineering, June 1992 (To Appear).

Rajkovic, V., M. Bohanec and J. Estathiou, "Ranking multiple options with DECMAK," Effective Decision Support Systems, edited by J. Hawgood and P. Humphreys, Technical Press, Brookfield, VT, (1987): pp. 49-69.

Sage, A.P., Information systems engineering for distributed decision making, School of Information Technology and Engineering, George Mason University, Working Paper, 1987.

Seybold, P., "Collective force: Tools for group productivity," Computerworld Focus (Dec 2, 1987): pp. 35-38.

Thierauf, R.J., Group Decision Support Systems for Effective Decision Making, Quorium Books, N.Y., 1989.

Vogel, D., and J. Nunamaker, "Group decision support system impact: Multi-methodological exploration," Paper presented at University of Minnesota MIS workshop, April 8, 1988.

BIBLIOGRAPHY

Applegate, L.M., B.R. Konsynski, and J.F. Nunamaker, "A Group decision support system for idea generation and issue analysis in organizational planning," In Proceedings of the Conference on Computer-Supported Cooperative Work, Austin, TX, 1986, Austin, TX: Conference Committee for CSCW, 1987.

Bui, T.X., and M.Jarke., "A DSS for cooperative multiple criteria group decision making," In proceedings of the Fifth International Conference on Information Systems, Tucson, AZ, 1983, N.p., 1984.

Chung L., "Representation and utilization of non-functional requirements for information system design," Lecture Notes in Computer Science: Advanced Information Systems Engineering, (May 1991): pp 5-30.

Chung L., P. Kataggrarianas, M. Marakis, M. Mertikas, J. Mylopovlos, and Y. Vassilou, "From information system requirements to designs: A mapping framework," Information Systems Vol 16, no 4 (1991): pp. 429-461.

Dennis, A.R., et al, "Information technology to support electronic meetings," MIS Quarterly 12, no. 4 (Dec. 1988): pp 591-624.

DeSanctis, G., V. Sambamurthy, and R.T. Watson, "Computer-supported meetings: Building a research environment," Large Scale Systems 13, no. 1 (1987): pp. 43-59.

Folger, J.P., D.E. Hewses, and M.S. Poole, "Coding social interaction," In Vol. 4 of Progress in Communication Sciences, edited by B. Dervin and M. Voight, Norwood, N.J.: Ablex, (1984): pp.115-161.

Forman, E.H., "Multi criteria decision making and the analytic hierarchy process," Readings in Multiple Criteria Decision Aid, (1990): pp. 295-318.

Gallupe, R.B. and J.D. Mckeen, "Enhancing computer-mediated communication: An experimental investigation into the use of a group decision support system for face-to-face versus remote meetings," Information and Management 18, (1990): pp. 1-13.

Gray, B., Collaborating: Finding common ground for multiparty problems, San Francisco, CA: Jossey-Bass, 1989.

Greif, I., and S. Sarin, "Data sharing in group work," In Computer-Supported Cooperative Work: A Book of Readings, edited by Irene Grief, San Mateo,CA, Morgan Kaufmann, (1988): pp. 477-508.

Jessup, L.M., D. Tansik, and T.D. Laase, "Group problem solving in an automated environment: The Effects of anonymity and proximity on group process and outcome with a group decision support system," Paper presented at the Academy of Management Conference, Anaheim, CA, August, 1988.

Jessup, L.M., T. Connally, and J. Galegher "The effects of anonymity on GDSS group process with an idea-generating task," MIS Quarterly (September 1990): pp. 313-320.

Kobayashi, S., and N. Ono, "A distributed problem solving approach to control asychronous and concurrent processes," Lecture Notes In Economics and Mathematical Systems 286, Vol 2., edited by Y. Sawaragi, K. Inoue, and H. Nakayama, Springer-Verlag, (1987): pp.20-29.

Kota, S., and C. Lee, "A look at an expert system for hydraulic design," Hydraulics and Pneumatics (May 1990): pp.48-51, 71.

Kraemer, K.L., and J.L. King, "Computer-based systems for cooperative work and group decision making," ACM Computing Surveys 20, no. 2 (June 1988): pp. 115-146.

Malone, T.W., et al., "Intelligent information-sharing systems," Communications of the ACM 30, no. 5 (1987): pp. 390-402.

Matarazzo, B., " A pairwise criterion comparison approach: The MAPPAC and PRAGMA Methods," Readings In Multiple Criteria Decision Aid," (1990): pp. 254-273.

Meeks, B.N., "An Overview of conferencing systems: A Guided tour through COM, EIES, PARTI, NOTEPAD and other systems," BYTE (December 1985): pp 169-184.

Minch, P., and G. Sanders, "Computerized information systems supporting multi-criteria decision-making," Decision Sciences (Summer 1986): pp. 395-413.

Nunamaker, J.F., L.M. Applegate, and B.R. Konsynski, "Facilitating group creativity: Experience with a group decision support system," In Proceedings of the Twentieth Annual Hawaii International Conference on System Sciences, Honolulu, HI, 1987, North Hollywood, CA: Western Periodicals Co., 1987.

Rathwell, M.A., and A. Burns, "Information systems support for group planning and decision-making activities," MIS Quarterly, no. 3 (Sept 1985): pp. 255-271.

Robey D., D.L. Farrow, and C.R. Franz, "Group process and conflict in system development," Management Science, Vol 35, no. 10 (Oct 1989): pp. 1172-1191.

Sawaragi, Y., "Towards interactive and intelligent decision support systems," Lecture Notes In Economics and Mathematical Systems 285, (1987): pp. 1-9.

Schwenk, C., and A.S. Huff, "Argumentation in strategic decision making," In Vol. 4 of Advances in Strategic Management, edited by Robert Lamb and Paul Shrivastrava, Greenwich, CT.: JAI Press, (1986): pp. 189-202.

Sharda, R., S.H. Barr, and J.C. McDonnell, "Decision support system effectiveness: A Review and an empirical test," Management Science 34, no. 2 (Feb 1988): pp. 139-159.

Siegel, J., et al., "Group processes in computer-mediated communication," Organizational Behavior and Human Decision Processes 37, (1986): pp. 157-187.

Smith, G.F., "Towards a heuristic theory of problem structuring," Management Science 34, no. 12 (Dec 1988): pp. 1489-1506.

Steeb, R., and S.C. Johnston, "A Computer-based interactive system for group decision making," IEEE Transactions on Systems, Man, and Cybernetics 11, no. 8 (1981): pp. 544-552.

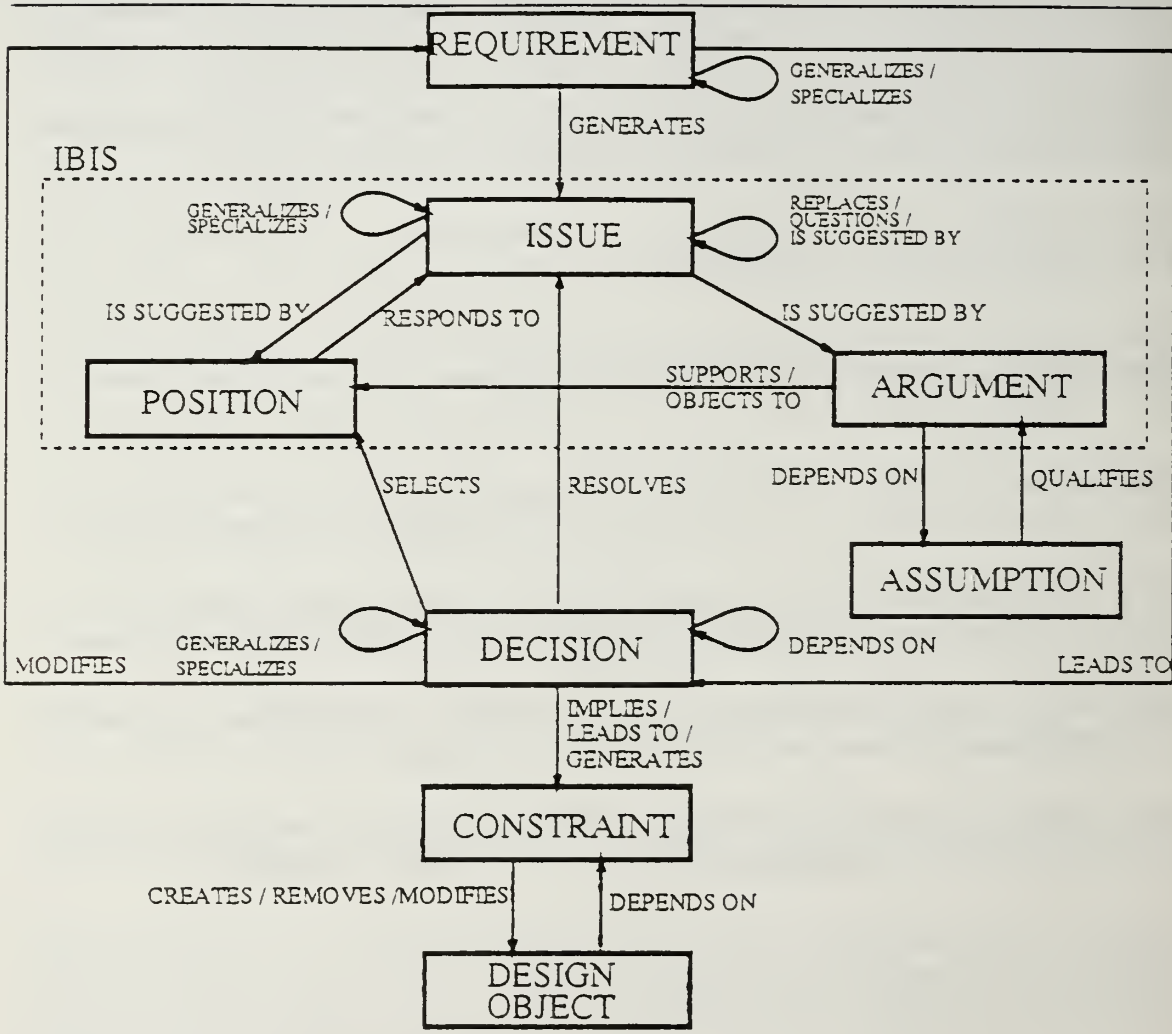
Stefik, M., et al., "Beyond the chalkboard: Computer support for collaboration and problem solving in meetings," Communications of the ACM 30, no. 1 (1987): pp. 32-47.

Todd, P., and I. Benbasat, Process tracing methods in decision support systems research: Exploring the Black Box, Working Paper no. 1140, University of British Columbia, 1986.

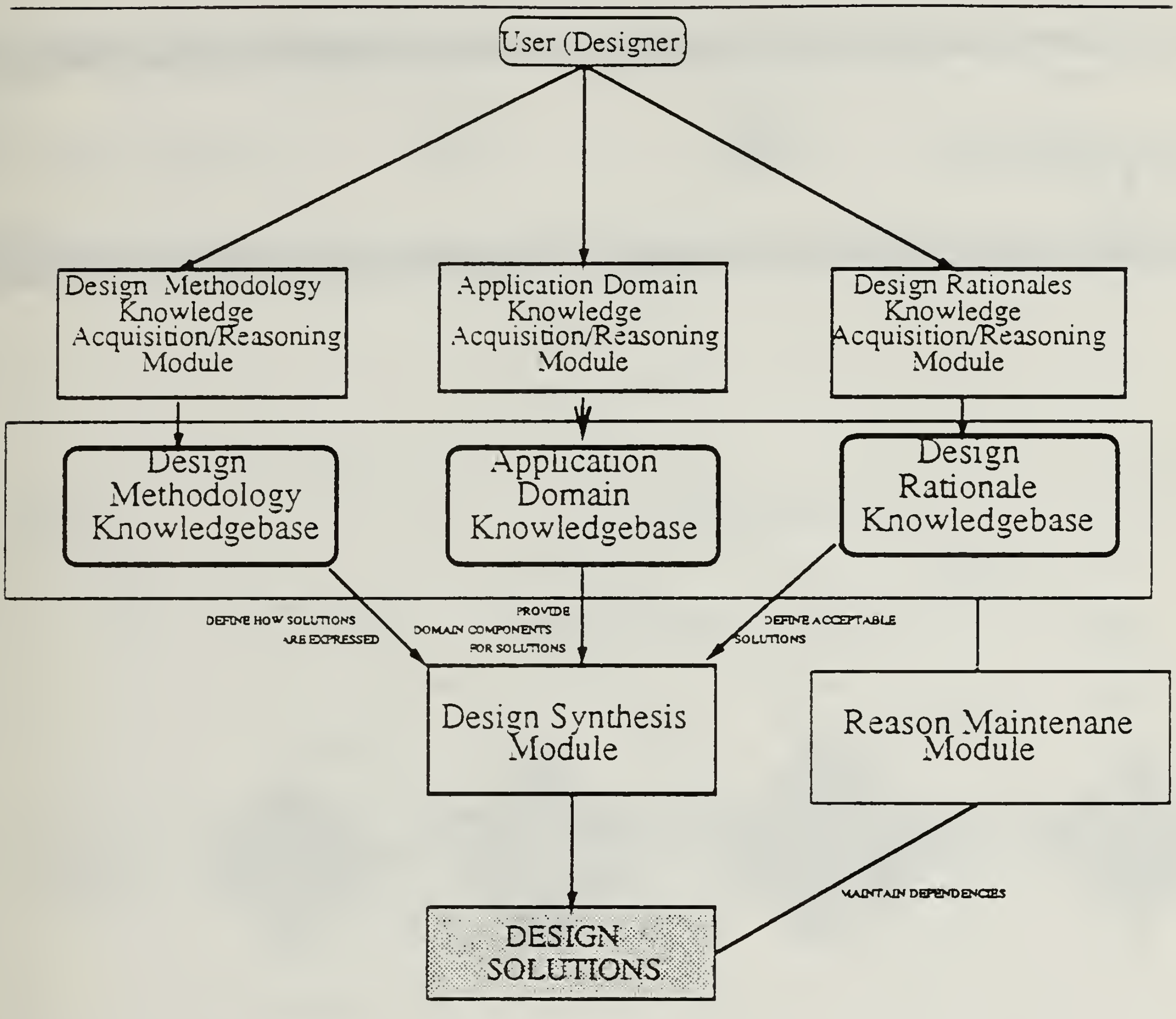
Turoff, M., and S.R. Hiltz, "Computer support for group versus individual decisions," IEEE Transactions on Communications 30, no. 1 (1982): pp. 82-90.

Zigurs, I., M.S. Poole, and G.L. DeSanctis, "A Study of influence in computer- mediated group decision making," MIS Quarterly 12, no. 4 (Dec 1988): pp. 625-644.

APPENDIX A: REMAP CONCEPTUAL MODEL

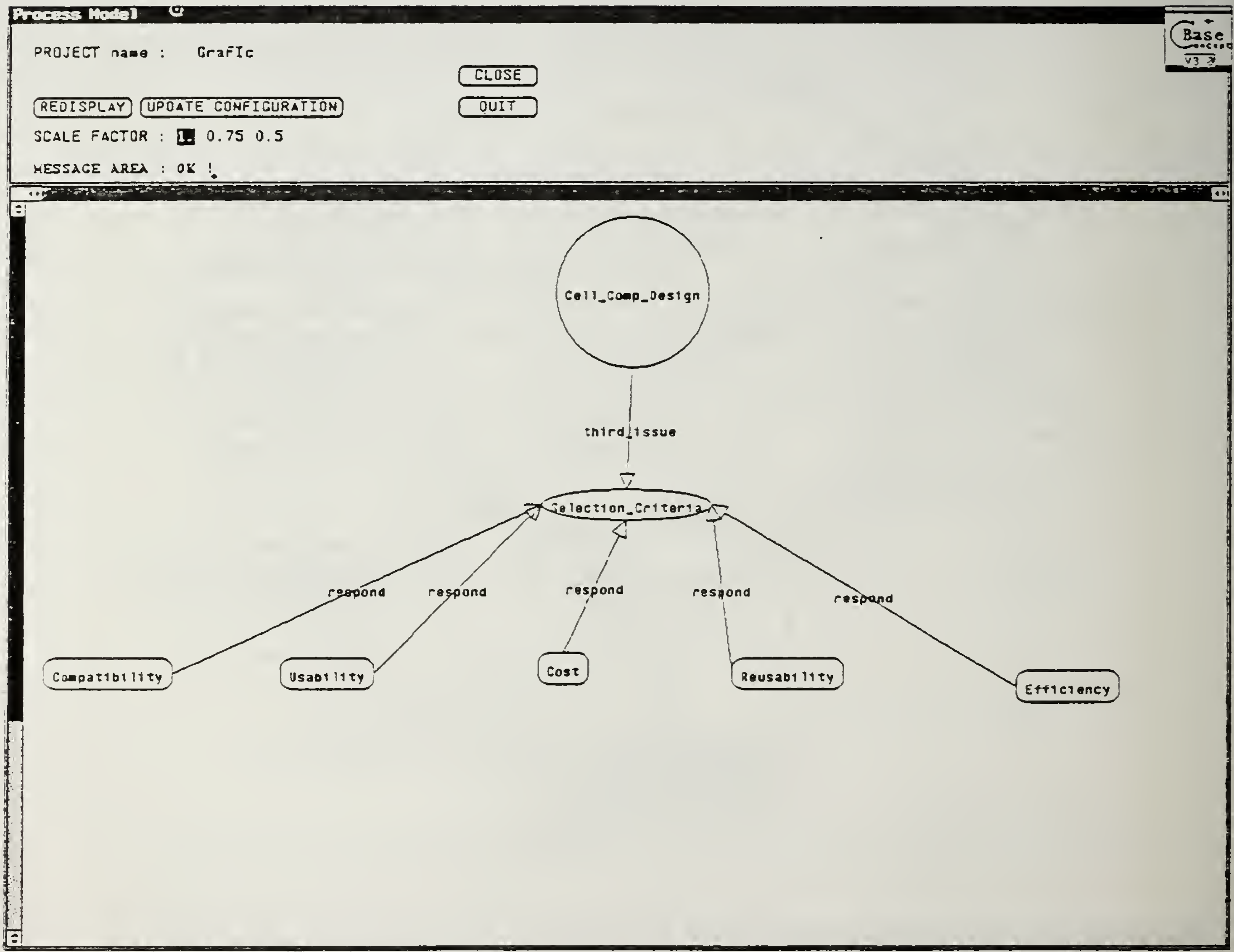


Schematic representation of the Conceptual Model

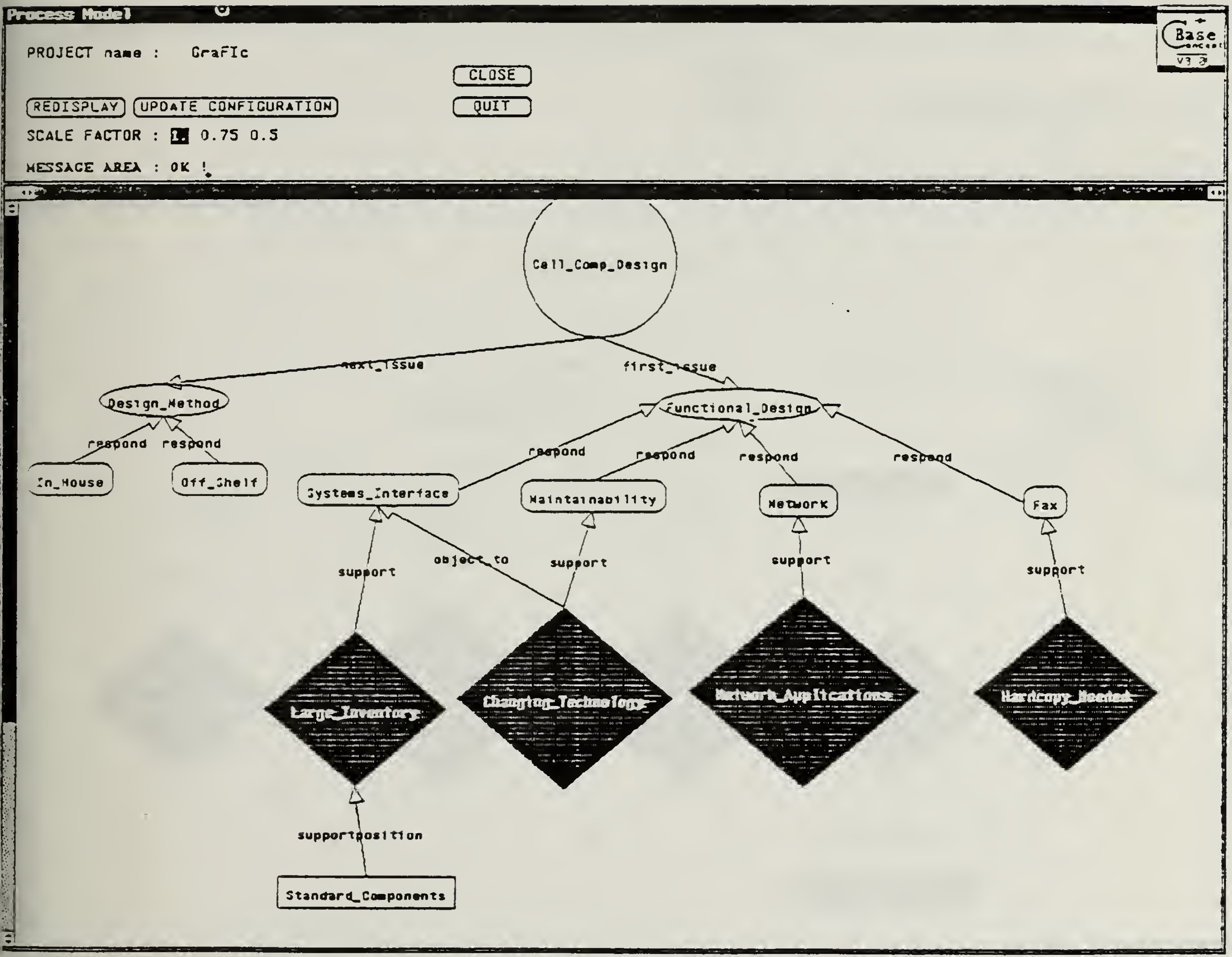


Schematic representation of the Environment Architecture

APPENDIX C: REMAP OUTPUT OF SELECTION CRITERIA

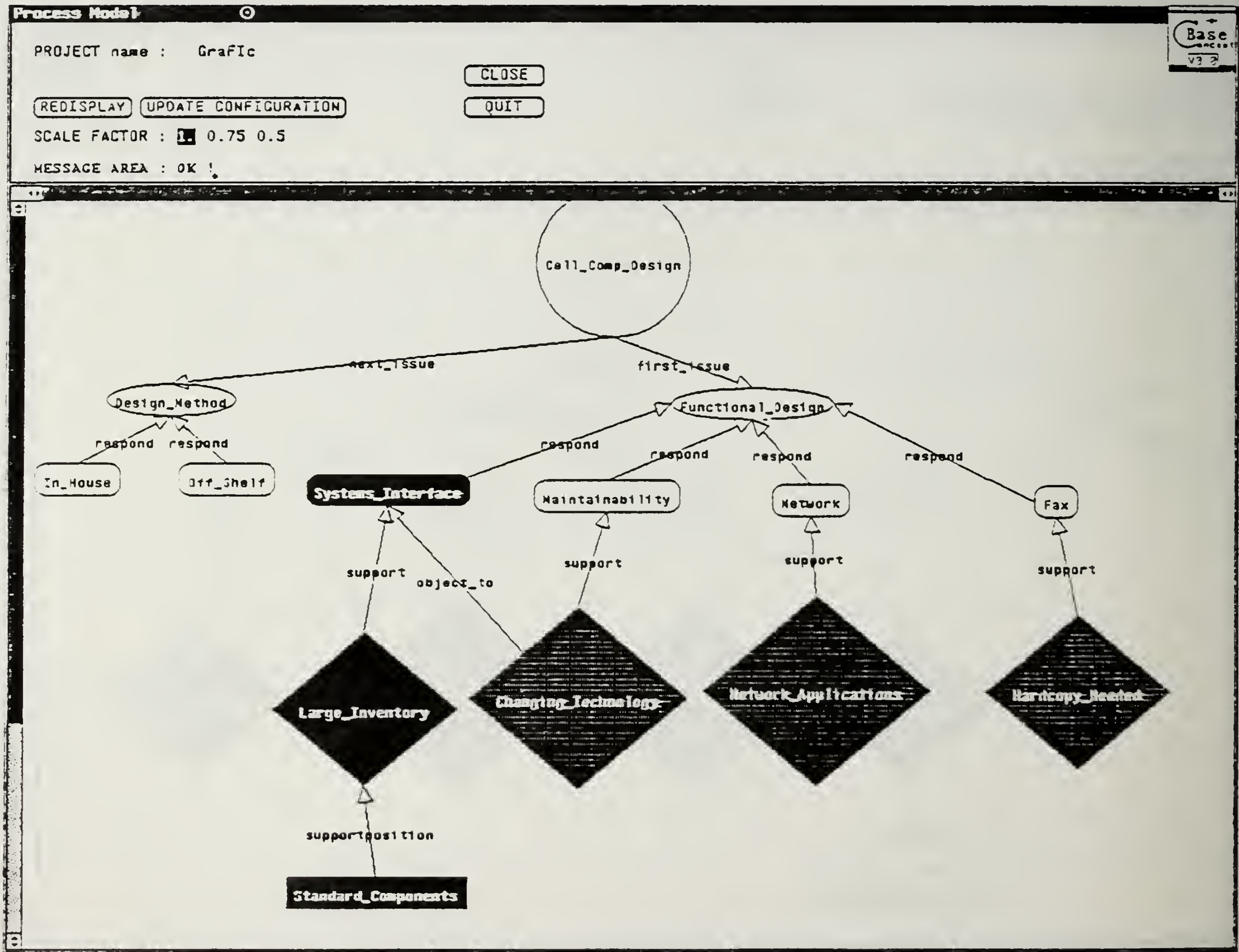


REMAP output of the TEST Case Selection Criteria



REMAP output of the Test Case with four Alternatives

APPENDIX E: REMAP OUTPUT WITH THREE ALTERNATIVES



REMAP output of the Test Case with three Alternatives

APPENDIX F: Co-oP TEST CASE RESULTS

MAIN MENU

1. MULTIPLE CRITERIA GROUP PROBLEM DEFINITION

2. GROUP NORM DEFINITION

3. PRIORITIZATION OF EVALUATION CRITERIA

4. INDIVIDUAL EVALUATION OF ALTERNATIVES

5, DIRECT INPUT OF THE DATA

6. COMPUTATION OF GROUP DECISION

7. IDENTIFICATION OF NEGOTIABLE ALTERNATIVES

8. EXIT

Enter a number :

MULTIPLE CRITERIA GROUP DSS - MAIN MENU
For HELP enter <ALT> R / <ESC> to quit HELP

NAME OF PROBLEM : cell_com

ENTER THE ALTERNATIVES :

1. System-Interface
2. Maintainability
3. Network
4. FAX

STEP 1 : MULTIPLE CRITERIA GROUP PROBLEM DEFINITION
Definition of Alternatives * Enter Q to quit

NAME OF PROBLEM : cell_com Enter the CRITERIA:

1. Usability
2. cost
3. Reusability
4. Compatibility
5. Efficiency

STEP 1 : MULTIPLE CRITERIA GROUP PROBLEM DEFINITION
Definition of Criteria * 1)st level 2)nd level 3)nd level Q)uit

1. USABILITY
2. COST
3. REUSABILITY
4. COMPATIBILITY
5. EFFICIENCY

Do You Want to Modify the Criteria (Y/N)   N

STEP 1 : MULTIPLE CRITERIA GROUP PROBLEM DEFINITION
Correct the data of the problem

ALTERNATIVES :

1. SYSTEM-INTERFACE
2. MAINTAINABILITY
3. NETWORK
4. FAX

Do You Want to Modify the ALTERNATIVES (Y/N) ? N

STEP 1 : MULTIPLE CRITERIA GROUP PROBLEM DEFINITION
Correct the data of the problem

```
NAME OF THE GROUP NORM : CELL_COMP_DESIGN
1. IDENTIFICATION OF GROUP MEMBERS

   1.1  Name of Norm Builder     : DM ONE

   1.2  Number of Group Members  : 4

        -  Name of Member  # 1   : DM ONE
        -  Name of Member  # 2   : DM TWO
        -  Name of Member  # 3   : DM THREE
        -  Name of Member  # 4   : DM FOUR




Press any key to continue
```

2. GROUP DECISION TECHNIQUES

2.1 Weighted Majority Rule

- Weights of Members :

1. DM ONE	:	1.00
2. DM TWO	:	1.00
3. DM THREE	:	1.00
4. DM FOUR	:	1.00

Press any key to continue

2.2 Collective Evaluation Mode :
Each group member will evaluate alternatives according to ALL criteria

Press any key to continue

2.3 Selection mode for transferring individual outcome to group decision techniques: method chosen by group members

2.4 Selection of Techniques of Aggregation of Preference : R1 R2 R3 R4

2.5 Automatic Computation of NAI : YES

3. INFORMATION EXCHANGE

3.1 Broadcasting of Individual Outputs : YES

3.2 Permission to Modify Individual Analysis AFTER Group Analysis : YES
You can Modify the Output 4 Times

3.3 Time Limit to Submit Individual Results :
3.3.1 DATE : 3-26-1992
3.3.2 HOUR : 12:00
3.3.3 Broadcasting of Group Results to Individuals Who Did NOT Submit Their Analysis : NO
3.3.4 Permission for Late Group Members to Perform Their Analysis After Deadline : NO

Press any key to continue

```
POSEY.DEF                                        DFAS.GN
BILLET.DEF                                       DFAS2.GN
Q.DEF                                            POSEY.GN
MONDAY.DEF                                       SUV.GN
QQ.DEF                                           DREW.GN
DSSFINAL.DEF                                     WEEK.GN
MAINT.DEF                                        RALPH.GN
REMAP.DEF                                        REMAP.GN
CELLU_CO.DEF                                     CELLU_CO.GN
HOLD_ON.DEF                                      CELL_COM.GN
CELL_COM.DEF                                     HOLD_ON.GN

THE NAME OF THE PROBLEM  ?   CELL_COMP_DESIGN

THE NAME OF THE NORM ?   CELL_COMP_DESIGN

YOUR NAME ?  DM ONE

YOUR ID ?     ****

THE METHOD THAT YOU WANT TO USE  ?           A

STEP 3 : PRIORITIZATION OF EVALUATION  CRITERIA
Identification of the problem  METHODS: AHP or DIRECT
```

PAIRWISE COMPARISION

	USABI	COST	EFFIC	REUSA	COMPA
USABI	1.00				
COST		1.00			
EFFIC			1.00		
REUSA				1.00	
COMPA					1.00

PRIORITY VECTOR

USABILITY	o	o
COST	o	o
EFFICIENCY	o	o
REUSABILITY	o	o
COMPATIBILITY	o	o

Is USABILITY more important than COST (Y/N/=) ? y
How many times is USABILITY more important than COST ? 1.25
(See note below)

"NOTE : Be as accurate as possible -- any # greater than 1 e.g, 2.45
A possible scale for inexact is :
1.25 = weakly important than ,1.50 = strongly more importan than
1.75 = very strongly more imp.than 2 = absolutely more imp. than

STEP 3 : PRIORITIZATION OF EVALUATION CRITERIA
Method : AHP

PAIRWISE COMPARISION

	USABI	COST	EFFIC	REUSA	COMPA
USABI	1.00	1.25			
COST	0.80	1.00			
EFFIC			1.00		
REUSA				1.00	
COMPA					1.00

PRIORITY VECTOR

USABILITY	o	o
COST	o	o
EFFICIENCY	o	o
REUSABILITY	o	o
COMPATIBILITY	o	o

Is USABILITY more important than EFFICIENCY (Y/N/=) ? n
How many times is EFFICIENCY more important than USABILITY ? 1.5
(See note below)

"NOTE : Be as accurate as possible -- any # greater than 1 e.g, 2.45
A possible scale for inexact is :
1.25 = weakly important than ,1.50 = strongly more importan than
1.75 = very strongly more imp.than 2 = absolutely more imp. than

STEP 3 : PRIORITIZATION OF EVALUATION CRITERIA
Method : AHP

PAIRWISE COMPARISION

	USABI	COST	EFFIC	REUSA	COMPA
USABI	1.00	1.25	0.67	0.71	
COST	0.80	1.00			
EFFIC	1.50		1.00		
REUSA	1.40			1.00	
COMPA					1.00

PRIORITY VECTOR

USABILITY	o	o
COST	o	o
EFFICIENCY	o	o
REUSABILITY	o	o
COMPATIBILITY	o	o

Is USABILITY more important than COMPATIBILITY (Y/N/=) ? y
How many times is USABILITY more important than COMPATIBILITY ? 1.6
(See note below)

"NOTE : Be as accurate as possible -- any # greater than 1 e.g, 2.45
A possible scale for inexact is :
1.25 = weakly important than ,1.50 = strongly more importan than
1.75 = very strongly more imp.than 2 = absolutely more imp. than

STEP 3 : PRIORITIZATION OF EVALUATION CRITERIA
Method : AHP

PAIRWISE COMPARISION

	USABI	COST	EFFIC	REUSA	COMPA
USABI	1.00	1.25	0.67	0.71	1.60
COST	0.80	1.00	1.25		
EFFIC	1.50	0.80	1.00		
REUSA	1.40			1.00	
COMPA	0.63				1.00

PRIORITY VECTOR

USABILITY	°	°
COST	°	°
EFFICIENCY	°	°
REUSABILITY	°	°
COMPATIBILITY	°	°

Is COST more important than REUSABILITY (Y/N/=) ? y
How many times is COST more important than REUSABILITY ? 1.3
(See note below)

"NOTE : Be as accurate as possible -- any # greater than 1 e.g, 2.45
A possible scale for inexact is :
1.25 = weakly important than ,1.50 = strongly more importan than
1.75 = very strongly more imp.than 2 = absolutely more imp. than

STEP 3 : PRIORITIZATION OF EVALUATION CRITERIA
Method : AHP

PAIRWISE COMPARISION

	USABI	COST	EFFIC	REUSA	COMPA
USABI	1.00	1.25	0.67	0.71	1.60
COST	0.80	1.00	1.25	1.30	
EFFIC	1.50	0.80	1.00		
REUSA	1.40	0.77		1.00	
COMPA	0.63				1.00

PRIORITY VECTOR

USABILITY	o	o
COST	o	o
EFFICIENCY	o	o
REUSABILITY	o	o
COMPATIBILITY	o	o

Is COST more important than COMPATIBILITY (Y/N/=) ? y
How many times is COST more important than COMPATIBILITY ? 1.2
(See note below)

"NOTE : Be as accurate as possible -- any # greater than 1 e.g, 2.45
A possible scale for inexact is :
1.25 = weakly important than ,1.50 = strongly more importan than
1.75 = very strongly more imp.than 2 = absolutely more imp. than

STEP 3 : PRIORITIZATION OF EVALUATION CRITERIA
Method : AHP

PAIRWISE COMPARISION

	USABI	COST	EFFIC	REUSA	COMPA
USABI	1.00	1.25	0.67	0.71	1.60
COST	0.80	1.00	1.25	1.30	1.20
EFFIC	1.50	0.80	1.00		
REUSA	1.40	0.77		1.00	
COMPA	0.63	0.83			1.00

PRIORITY VECTOR

USABILITY	o	o
COST	o	o
EFFICIENCY	o	o
REUSABILITY	o	o
COMPATIBILITY	o	o

Is EFFICIENCY more important than REUSABILITY (Y/N/=) ? y
How many times is EFFICIENCY more important than REUSABILITY ? 1.7
(See note below)

"NOTE : Be as accurate as possible -- any # greater than 1 e.g, 2.45
A possible scale for inexact is :
1.25 = weakly important than ,1.50 = strongly more importan than
1.75 = very strongly more imp.than 2 = absolutely more imp. than

STEP 3 : PRIORITIZATION OF EVALUATION CRITERIA
Method : AHP

PAIRWISE COMPARISION

	USABI	COST	EFFIC	REUSA	COMPA
USABI	1.00	1.25	0.67	0.71	1.60
COST	0.80	1.00	1.25	1.30	1.20
EFFIC	1.50	0.80	1.00	1.70	1.40
REUSA	1.40	0.77	0.59	1.00	0.77
COMPA	0.63	0.83	0.71	1.30	1.00

PRIORITY VECTOR

EFFICIENCY	°0.242 °
COST	°0.215 °
USABILITY	°0.199 °
REUSABILITY	°0.173 °
COMPATIBILITY	°0.170 °

** LAMDA MAX = 5.14
CONSISTENCY INDEX = 0.04
RANDOMIZED INDEX = 1.12
CONSISTENCY RATIO = 0.03

** THERE IS SOME STATISTICAL INCONSISTENCY IN YOUR EVALUATION. (STUDY HIGHLIGHTED VALUES FOR PROBABLE INCONSISTENT EVALUATION)

EFF COS USA REU COM

DO YOU WANT TO MODIFY THE EVALUATION OF THE CRITERIA (Y/N) ?

STEP 3 : PRIORITIZATION OF EVALUATION CRITERIA
Method : AHP

```
 THE FINAL CRITERIA ( 5)  AND THEIR WEIGHTS ARE  :
1. EFFICIENCY                  : 0.24
2. COST                        : 0.22
3. USABILITY                   : 0.20
4. REUSABILITY                 : 0.17
5. COMPATIBILITY               : 0.17
```

```
DO YOU WANT TO REDUCE THE NUMBER OF THE CRITERIA (Y/N) ?
```

```
STEP 3 : PRIORITIZATION OF EVALUATION  CRITERIA
Determine the number of the criteria
```

```
 THE FINAL CRITERIA ( 5)  AND THEIR WEIGHTS ARE  :
1. EFFICIENCY                     : 0.24
2. COST                           : 0.22
3. USABILITY                      : 0.20
4. REUSABILITY                    : 0.17
5. COMPATIBILITY                  : 0.17
```

```
DO YOU WANT TO CHANGE THE NUMBER OF THE CRITERIA (Y/N) ?
```

```
STEP 3 : PRIORITIZATION OF EVALUATION  CRITERIA
Determine the number of the criteria
```

```
POSEY.DEF                                   DFAS.GN
BILLET.DEF                                  DFAS2.GN
Q.DEF                                       POSEY.GN
MONDAY.DEF                                  SUV.GN
QQ.DEF                                      DREW.GN
DSSFINAL.DEF                                WEEK.GN
MAINT.DEF                                   RALPH.GN
REMAP.DEF                                   REMAP.GN
CELLU_CO.DEF                                CELLU_CO.GN
HOLD_ON.DEF                                 CELL_COM.GN
CELL_COM.DEF                                HOLD_ON.GN

 DO YOU WANT TO SEE A PREDEFINED NORM (Y/N) ?        N


STEP 3 : PRIORITIZATION OF EVALUATION  CRITERIA
Files related to the problem
```

```
POSEY.DEF                                        DFAS.GN
BILLET.DEF                                       DFAS2.GN
Q.DEF                                            POSEY.GN
MONDAY.DEF                                       SUV.GN
QQ.DEF                                           DREW.GN
DSSFINAL.DEF                                     WEEK.GN
MAINT.DEF                                        RALPH.GN
REMAP.DEF                                        REMAP.GN
CELLU_CO.DEF                                     CELLU_CO.GN
HOLD_ON.DEF                                      CELL_COM.GN
CELL_COM.DEF                                     HOLD_ON.GN

 DO YOU WANT TO SEE A PREDEFINED PROBLEM (Y/N) ?     N




STEP 3 : PRIORITIZATION OF EVALUATION  CRITERIA
Files related to the problem
```

```
POSEY.DEF                                 DFAS.GN
BILLET.DEF                                DFAS2.GN
Q.DEF                                     POSEY.GN
MONDAY.DEF                                SUV.GN
QQ.DEF                                    DREW.GN
DSSFINAL.DEF                              WEEK.GN
MAINT.DEF                                 RALPH.GN
REMAP.DEF                                 REMAP.GN
CELLU_CO.DEF                              CELLU_CO.GN
HOLD_ON.DEF                               CELL_COM.GN
CELL_COM.DEF                              HOLD_ON.GN

THE NAME OF THE PROBLEM  ?   Cell_COMP_DESIGN

THE NAME OF THE NORM ?   CELL_COMP_DESIGN

YOUR NAME ?  DM TWO

YOUR ID ?    ****

THE METHOD THAT YOU WANT TO USE  ?          D

STEP 3 : PRIORITIZATION OF EVALUATION  CRITERIA
Identification of the problem  METHODS: AHP or DIRECT
       .
```

RAW INPUT		PRIORITY VECTOR		
USABILITY:		USABILITY	°	°
COST :		COST	°	°
REUSABILI:		REUSABILI	°	°
COMPATIBI:		COMPATIBI	°	°
EFFICIENC:		EFFICIENC	°	°

Enter the weights (0 - 10) of the CRITERIAS :

USABILITY	: 7.5
COST	: 9
REUSABILITY	: 10
COMPATIBILITY	: 6.5
EFFICIENCY	: 8

STEP 3 : PRIORITIZATION OF EVALUATION CRITERIA
Direct input of criteria weights

```
  RAW INPUT                                         PRIORITY VECTOR

USABILITY:  7.50                                  REUSABILI ° 0.244°
COST     :  9.00                                  COST      ° 0.220°
REUSABILI: 10.00                                  EFFICIENC ° 0.195°
COMPATIBI:  6.50                                  USABILITY ° 0.183°
EFFICIENC:  8.00                                  COMPATIBI ° 0.159°
```

```
REU  COS  EFF  USA  COM
0.24 0.22 0.20 0.18 0.16
 DO YOU WANT TO MODIFY THE EVALUATION OF THE CRITERIA (Y/N) ?

STEP 3 : PRIORITIZATION OF EVALUATION  CRITERIA
Direct input of criteria weights
```

```
 THE FINAL CRITERIA ( 5)  AND THEIR WEIGHTS ARE  :
1. REUSABILITY                 : 0.24
2. COST                        : 0.22
3. EFFICIENCY                  : 0.20
4. USABILITY                   : 0.18
5. COMPATIBILITY               : 0.16



DO YOU WANT TO REDUCE THE NUMBER OF THE CRITERIA (Y/N) ?



STEP 3 : PRIORITIZATION OF EVALUATION  CRITERIA
Determine the number of the criteria
```

```
 THE FINAL CRITERIA ( 5)  AND THEIR WEIGHTS ARE  :
1. REUSABILITY                  : 0.24
2. COST                         : 0.22
3. EFFICIENCY                   : 0.20
4. USABILITY                    : 0.18
5. COMPATIBILITY                : 0.16
```

```
DO YOU WANT TO CHANGE THE NUMBER OF THE CRITERIA (Y/N) ?
```

```
STEP 3 : PRIORITIZATION OF EVALUATION  CRITERIA
Determine the number of the criteria
```

```
POSEY.DEF                                DFAS.GN
BILLET.DEF                               DFAS2.GN
Q.DEF                                    POSEY.GN
MONDAY.DEF                               SUV.GN
QQ.DEF                                   DREW.GN
DSSFINAL.DEF                             WEEK.GN
MAINT.DEF                                RALPH.GN
REMAP.DEF                                REMAP.GN
CELLU_CO.DEF                             CELLU_CO.GN
HOLD_ON.DEF                              CELL_COM.GN
CELL_COM.DEF                             HOLD_ON.GN

THE NAME OF THE PROBLEM  ?   CELL_COMP_DESIGN

THE NAME OF THE NORM ?   CELL_COMP_DESIGN

YOUR NAME ?  DM THREE

YOUR ID ?    ****

THE METHOD THAT YOU WANT TO USE  ?           A

STEP 3 : PRIORITIZATION OF EVALUATION  CRITERIA
Identification of the problem  METHODS: AHP or DIRECT
```

PAIRWISE COMPARISION

	USABI	COST	EFFIC	REUSA	COMPA
USABI	1.00				
COST		1.00			
EFFIC			1.00		
REUSA				1.00	
COMPA					1.00

PRIORITY VECTOR

USABILITY	°	°
COST	°	°
EFFICIENCY	°	°
REUSABILITY	°	°
COMPATIBILITY	°	°

Is USABILITY more important than COST (Y/N/=) ? n
How many times is COST more important than USABILITY ? 1.5
(See note below)

"NOTE : Be as accurate as possible -- any # greater than 1 e.g, 2.45
A possible scale for inexact is :
1.25 = weakly important than ,1.50 = strongly more importan than
1.75 = very strongly more imp.than 2 = absolutely more imp. than

STEP 3 : PRIORITIZATION OF EVALUATION CRITERIA
Method : AHP

PAIRWISE COMPARISION

	USABI	COST	EFFIC	REUSA	COMPA
USABI	1.00	0.67			
COST	1.50	1.00			
EFFIC			1.00		
REUSA				1.00	
COMPA					1.00

PRIORITY VECTOR

USABILITY	o	o
COST	o	o
EFFICIENCY	o	o
REUSABILITY	o	o
COMPATIBILITY	o	o

Is USABILITY more important than EFFICIENCY (Y/N/=) ? n
How many times is EFFICIENCY more important than USABILITY ? 1.25
(See note below)

"NOTE : Be as accurate as possible -- any # greater than 1 e.g, 2.45
A possible scale for inexact is :
1.25 = weakly important than ,1.50 = strongly more importan than
1.75 = very strongly more imp.than 2 = absolutely more imp. than

STEP 3 : PRIORITIZATION OF EVALUATION CRITERIA
Method : AHP

PAIRWISE COMPARISION

	USABI	COST	EFFIC	REUSA	COMPA
USABI	1.00	0.67	0.80		
COST	1.50	1.00			
EFFIC	1.25		1.00		
REUSA				1.00	
COMPA					1.00

PRIORITY VECTOR

USABILITY	o	o
COST	o	o
EFFICIENCY	o	o
REUSABILITY	o	o
COMPATIBILITY	o	o

Is USABILITY more important than REUSABILITY (Y/N/=) ? y
How many times is USABILITY more important than REUSABILITY ? 1.6
(See note below)

"NOTE : Be as accurate as possible -- any # greater than 1 e.g, 2.45
A possible scale for inexact is :
1.25 = weakly important than ,1.50 = strongly more importan than
1.75 = very strongly more imp.than 2 = absolutely more imp. than

STEP 3 : PRIORITIZATION OF EVALUATION CRITERIA
Method : AHP

PAIRWISE COMPARISION

	USABI	COST	EFFIC	REUSA	COMPA
USABI	1.00	0.67	0.80	1.60	
COST	1.50	1.00			
EFFIC	1.25		1.00		
REUSA	0.63			1.00	
COMPA					1.00

PRIORITY VECTOR

USABILITY	°	°
COST	°	°
EFFICIENCY	°	°
REUSABILITY	°	°
COMPATIBILITY	°	°

Is USABILITY more important than COMPATIBILITY (Y/N/=) ? y
How many times is USABILITY more important than COMPATIBILITY ? 1.6
(See note below)

"NOTE : Be as accurate as possible -- any # greater than 1 e.g, 2.45
A possible scale for inexact is :
1.25 = weakly important than ,1.50 = strongly more importan than
1.75 = very strongly more imp.than 2 = absolutely more imp. than

STEP 3 : PRIORITIZATION OF EVALUATION CRITERIA
Method : AHP

PAIRWISE COMPARISION

	USABI	COST	EFFIC	REUSA	COMPA
USABI	1.00	0.67	0.80	1.60	1.60
COST	1.50	1.00			
EFFIC	1.25		1.00		
REUSA	0.63			1.00	
COMPA	0.63				1.00

PRIORITY VECTOR

USABILITY	°	°
COST	°	°
EFFICIENCY	°	°
REUSABILITY	°	°
COMPATIBILITY	°	°

Is COST more important than EFFICIENCY (Y/N/=) ? y
How many times is COST more important than EFFICIENCY ? 1.34
(See note below)

"NOTE : Be as accurate as possible -- any # greater than 1 e.g, 2.45
A possible scale for inexact is :
1.25 = weakly important than ,1.50 = strongly more importan than
1.75 = very strongly more imp.than 2 = absolutely more imp. than

STEP 3 : PRIORITIZATION OF EVALUATION CRITERIA
Method : AHP

PAIRWISE COMPARISION

	USABI	COST	EFFIC	REUSA	COMPA
USABI	1.00	0.67	0.80	1.60	1.60
COST	1.50	1.00	1.34		
EFFIC	1.25	0.75	1.00		
REUSA	0.63			1.00	
COMPA	0.63				1.00

PRIORITY VECTOR

USABILITY	°	°
COST	°	°
EFFICIENCY	°	°
REUSABILITY	°	°
COMPATIBILITY	°	°

Is COST more important than REUSABILITY (Y/N/=) ? y
How many times is COST more important than REUSABILITY ? 1.45
(See note below)

"NOTE : Be as accurate as possible -- any # greater than 1 e.g, 2.45
A possible scale for inexact is :
1.25 = weakly important than ,1.50 = strongly more importan than
1.75 = very strongly more imp.than 2 = absolutely more imp. than

STEP 3 : PRIORITIZATION OF EVALUATION CRITERIA
Method : AHP

PAIRWISE COMPARISION

	USABI	COST	EFFIC	REUSA	COMPA
USABI	1.00	0.67	0.80	1.60	1.60
COST	1.50	1.00	1.34	1.45	
EFFIC	1.25	0.75	1.00		
REUSA	0.63	0.69		1.00	
COMPA	0.63				1.00

PRIORITY VECTOR

USABILITY	°	°
COST	°	°
EFFICIENCY	°	°
REUSABILITY	°	°
COMPATIBILITY	°	°

Is COST more important than COMPATIBILITY (Y/N/=) ? y
How many times is COST more important than COMPATIBILITY ? 1.6
(See note below)

"NOTE : Be as accurate as possible -- any # greater than 1 e.g, 2.45
A possible scale for inexact is :
1.25 = weakly important than ,1.50 = strongly more importan than
1.75 = very strongly more imp.than 2 = absolutely more imp. than

STEP 3 : PRIORITIZATION OF EVALUATION CRITERIA
Method : AHP

PAIRWISE COMPARISION

	USABI	COST	EFFIC	REUSA	COMPA
USABI	1.00	0.67	0.80	1.60	1.60
COST	1.50	1.00	1.34	1.45	1.60
EFFIC	1.25	0.75	1.00	1.60	
REUSA	0.63	0.69	0.63	1.00	
COMPA	0.63	0.63			1.00

PRIORITY VECTOR

USABILITY	°	°
COST	°	°
EFFICIENCY	°	°
REUSABILITY	°	°
COMPATIBILITY	°	°

Is EFFICIENCY more important than COMPATIBILITY (Y/N/=) ? n
How many times is COMPATIBILITY more important than EFFICIENCY ? 1.25
(See note below)

"NOTE : Be as accurate as possible -- any # greater than 1 e.g, 2.45
A possible scale for inexact is :
1.25 = weakly important than ,1.50 = strongly more importan than
1.75 = very strongly more imp.than 2 = absolutely more imp. than

STEP 3 : PRIORITIZATION OF EVALUATION CRITERIA
Method : AHP

PAIRWISE COMPARISION

	USABI	COST	EFFIC	REUSA	COMPA
USABI	1.00	0.67	0.80	1.60	1.60
COST	1.50	1.00	1.34	1.45	1.60
EFFIC	1.25	0.75	1.00	1.60	0.80
REUSA	0.63	0.69	0.63	1.00	
COMPA	0.63	0.63	1.25		1.00

PRIORITY VECTOR

USABILITY	°	°
COST	°	°
EFFICIENCY	°	°
REUSABILITY	°	°
COMPATIBILITY	°	°

Is REUSABILITY more important than COMPATIBILITY (Y/N/=) ? n
How many times is COMPATIBILITY more important than REUSABILITY ? 1.4
(See note below)

"NOTE : Be as accurate as possible -- any # greater than 1 e.g, 2.45
A possible scale for inexact is :
1.25 = weakly important than ,1.50 = strongly more importan than
1.75 = very strongly more imp.than 2 = absolutely more imp. than

STEP 3 : PRIORITIZATION OF EVALUATION CRITERIA
Method : AHP

PAIRWISE COMPARISION

	USABI	COST	EFFIC	REUSA	COMPA
USABI	1.00	0.67	0.80	1.60	1.60
COST	1.50	1.00	1.34	1.45	1.60
EFFIC	1.25	0.75	1.00	1.60	0.80
REUSA	0.63	0.69	0.63	1.00	0.71
COMPA	0.63	0.63	1.25	1.40	1.00

PRIORITY VECTOR

COST	°0.265 °
USABILITY	°0.209 °
EFFICIENCY	°0.203 °
COMPATIBILITY	°0.183 °
REUSABILITY	°0.140 °

** LAMDA MAX = 5.08
CONSISTENCY INDEX = 0.02
RANDOMIZED INDEX = 1.12
CONSISTENCY RATIO = 0.02

** Your Evaluation is More or Less Consistent.

COS USA EFF COM REU
DO YOU WANT TO MODIFY THE EVALUATION OF THE CRITERIA (Y/N) ? N

STEP 3 : PRIORITIZATION OF EVALUATION CRITERIA
Method : AHP

```
 THE FINAL CRITERIA ( 5)  AND THEIR WEIGHTS ARE   :
1. COST                         : 0.26
2. USABILITY                    : 0.21
3. EFFICIENCY                   : 0.20
4. COMPATIBILITY                : 0.18
5. REUSABILITY                  : 0.14
```

```
DO YOU WANT TO REDUCE THE NUMBER OF THE CRITERIA (Y/N) ?
```

```
STEP 3 : PRIORITIZATION OF EVALUATION  CRITERIA
Determine the number of the criteria
```

```
 THE FINAL CRITERIA ( 5)  AND THEIR WEIGHTS ARE  :
1. COST                      : 0.26
2. USABILITY                 : 0.21
3. EFFICIENCY                : 0.20
4. COMPATIBILITY             : 0.18
5. REUSABILITY               : 0.14
```

```
DO YOU WANT TO CHANGE THE NUMBER OF THE CRITERIA (Y/N) ?             N
```

```
STEP 3 : PRIORITIZATION OF EVALUATION  CRITERIA
Determine the number of the criteria
```

```
POSEY.DEF                                        DFAS.GN
BILLET.DEF                                       DFAS2.GN
Q.DEF                                            POSEY.GN
MONDAY.DEF                                       SUV.GN
QQ.DEF                                           DREW.GN
DSSFINAL.DEF                                     WEEK.GN
MAINT.DEF                                        RALPH.GN
REMAP.DEF                                        REMAP.GN
CELLU_CO.DEF                                     CELLU_CO.GN
HOLD_ON.DEF                                      CELL_COM.GN
CELL_COM.DEF                                     HOLD_ON.GN

THE NAME OF THE PROBLEM  ?   CELL_COMP_DESIGN

THE NAME OF THE NORM ?   CELL_COMP_DESIGN

YOUR NAME ?  DM FOUR

YOUR ID ?     ****

THE METHOD THAT YOU WANT TO USE  ?            D

STEP 3 : PRIORITIZATION OF EVALUATION  CRITERIA
Identification of the problem  METHODS: AHP or DIRECT
```

```
  RAW INPUT                                        PRIORITY VECTOR

USABILITY:                                       USABILITY °       °
COST      :                                      COST      °       °
REUSABILI:                                       REUSABILI °       °
COMPATIBI:                                       COMPATIBI °       °
EFFICIENC:                                       EFFICIENC °       °


Enter the weights (0 - 10) of the CRITERIAS :

USABILITY                    : 7
COST                         : 9
REUSABILITY                  : 5
COMPATIBILITY                : 5
EFFICIENCY                   : 3.5


STEP 3 : PRIORITIZATION OF EVALUATION  CRITERIA
Direct input of criteria weights
```

RAW INPUT		PRIORITY VECTOR	
USABILITY:	7.00	COST	° 0.305°
COST :	9.00	USABILITY	° 0.237°
REUSABILI:	5.00	REUSABILI	° 0.169°
COMPATIBI:	5.00	COMPATIBI	° 0.169°
EFFICIENC:	3.50	EFFICIENC	° 0.119°

```
COS  USA  REU  COM  EFF
0.31 0.24 0.17 0.17 0.12
 DO YOU WANT TO MODIFY THE EVALUATION OF THE CRITERIA (Y/N) ?

STEP 3 : PRIORITIZATION OF EVALUATION  CRITERIA
Direct input of criteria weights
```

```
 THE FINAL CRITERIA ( 5)  AND THEIR WEIGHTS ARE  :
1. COST                        : 0.31
2. USABILITY                   : 0.24
3. REUSABILITY                 : 0.17
4. COMPATIBILITY               : 0.17
5. EFFICIENCY                  : 0.12
```

```
DO YOU WANT TO REDUCE THE NUMBER OF THE CRITERIA (Y/N) ?
```

```
STEP 3 : PRIORITIZATION OF EVALUATION  CRITERIA
Determine the number of the criteria
```

```
 THE FINAL CRITERIA ( 5)  AND THEIR WEIGHTS ARE  :
1. COST                         : 0.31
2. USABILITY                    : 0.24
3. REUSABILITY                  : 0.17
4. COMPATIBILITY                : 0.17
5. EFFICIENCY                   : 0.12
```

```
DO YOU WANT TO CHANGE THE NUMBER OF THE CRITERIA (Y/N) ?             N
```

```
STEP 3 : PRIORITIZATION OF EVALUATION  CRITERIA
Determine the number of the criteria
```

```
POSEY.DEF                                DFAS.GN
BILLET.DEF                               DFAS2.GN
Q.DEF                                    POSEY.GN
MONDAY.DEF                               SUV.GN
QQ.DEF                                   DREW.GN
DSSFINAL.DEF                             WEEK.GN
MAINT.DEF                                RALPH.GN
REMAP.DEF                                REMAP.GN
CELLU_CO.DEF                             CELLU_CO.GN
HOLD_ON.DEF                              CELL_COM.GN
CELL_COM.DEF                             HOLD_ON.GN

THE NAME OF THE PROBLEM  ?   CELL_COMP_DESIGN

THE NAME OF THE NORM ?   CELL_COMP_DESIGN

YOUR NAME ?  DM ONE

YOUR ID ?    ****

THE METHOD THAT YOU WANT TO USE  ?           E

STEP 4 : INDIVIDUAL EVALUATION OF ALTERNATIVES
Identification of the problem   METHODS : AHP, ELECTRE, DIRECT
```

U ALTERN.EVALUATION: WORKING AREA GRADING SCALE

	EFFI	USAB	COMP	COST	REUS
SYST					
MAIN					
NETW					
FAX					

	EFFI	USAB	COMP	COST	REUS
Weig:	26	24	21	15	15
Exce	26	24	21	15	15
Good	20	18	15	11	11
Aver	13	12	10	7	7
Fair	7	6	5	4	4
Weak	0	0	0	0	0

* If the individual solution is evaluated with method ELECTRE then Ordinal, and Cardinal Rankings of the group evaluation are calculated as follows:

(1) The Ordinal Ranking is determined by the Sum of Outranking Relations.
(2) The Cardinal Ranking is shown by the Additive Utility.

Press any key to continue
STEP 4 : EVALUATION OF ALTERNATIVES
Method used : ELECTRE

U ALTERN.EVALUATION: WORKING AREA

	EFFI	USAB	COMP	COST	REUS
SYST	16	18	14	8	
MAIN					
NETW					
FAX					

GRADING SCALE

	EFFI	USAB	COMP	COST	REUS
Weig:	26	24	21	15	15
Exce	26	24	21	15	15
Good	20	18	15	11	11
Aver	13	12	10	7	7
Fair	7	6	5	4	4
Weak	0	0	0	0	0

** EVALUATE ALTERNATIVE SYSTEM_INTREFACE:

1 - For criterion EFFICIENCY any value between 0 and 26 ? 16
2 - For criterion USABILITY any value between 0 and 24 ? 18
3 - For criterion COMPATIBILITY any value between 0 and 21 ? 14
4 - For criterion COST any value between 0 and 15 ? 8
5 - For criterion REUSABILITY any value between 0 and 15 ? 17

STEP 4 : EVALUATION OF ALTERNATIVES
Method used : ELECTRE

U ALTERN.EVALUATION: WORKING AREA GRADING SCALE

	EFFI	USAB	COMP	COST	REUS
SYST	16	18	14	8	5
MAIN	21	19	16	8	
NETW					
FAX					

	EFFI	USAB	COMP	COST	REUS
Weig:	26	24	21	15	15
Exce	26	24	21	15	15
Good	20	18	15	11	11
Aver	13	12	10	7	7
Fair	7	6	5	4	4
Weak	0	0	0	0	0

** EVALUATE ALTERNATIVE MAINTAINABILITY:

1 - For criterion EFFICIENCY any value between 0 and 26 ? 21
2 - For criterion USABILITY any value between 0 and 24 ? 19
3 - For criterion COMPATIBILITY any value between 0 and 21 ? 16
4 - For criterion COST any value between 0 and 15 ? 8
5 - For criterion REUSABILITY any value between 0 and 15 ? 13

STEP 4 : EVALUATION OF ALTERNATIVES
Method used : ELECTRE

U ALTERN.EVALUATION: WORKING AREA

	EFFI	USAB	COMP	COST	REUS
SYST	16	18	14	8	5
MAIN	21	19	16	8	13
NETW	16	19	11	10	
FAX					

GRADING SCALE

	EFFI	USAB	COMP	COST	REUS
Weig:	26	24	21	15	15
Exce	26	24	21	15	15
Good	20	18	15	11	11
Aver	13	12	10	7	7
Fair	7	6	5	4	4
Weak	0	0	0	0	0

** EVALUATE ALTERNATIVE NETWORK:

1 - For criterion EFFICIENCY any value between 0 and 26 ? 16
2 - For criterion USABILITY any value between 0 and 24 ? 19
3 - For criterion COMPATIBILITY any value between 0 and 21 ? 11
4 - For criterion COST any value between 0 and 15 ? 10
5 - For criterion REUSABILITY any value between 0 and 15 ? 7

STEP 4 : EVALUATION OF ALTERNATIVES
Method used : ELECTRE

U ALTERN.EVALUATION: WORKING AREA GRADING SCALE

	EFFI	USAB	COMP	COST	REUS
SYST	16	18	14	8	5
MAIN	21	19	16	8	13
NETW	16	19	11	10	7
FAX	15	18	14	15	

	EFFI	USAB	COMP	COST	REUS
Weig:	26	24	21	15	15
Exce	26	24	21	15	15
Good	20	18	15	11	11
Aver	13	12	10	7	7
Fair	7	6	5	4	4
Weak	0	0	0	0	0

** EVALUATE ALTERNATIVE FAX:

1 - For criterion EFFICIENCY any value between 0 and 26 ? 15
2 - For criterion USABILITY any value between 0 and 24 ? 18
3 - For criterion COMPATIBILITY any value between 0 and 21 ? 14
4 - For criterion COST any value between 0 and 15 ? 15
5 - For criterion REUSABILITY any value between 0 and 15 ? 6

STEP 4 : EVALUATION OF ALTERNATIVES
Method used : ELECTRE

U ALTERN.EVALUATION: WORKING AREA

	EFFI	USAB	COMP	COST	REUS
SYST	16	18	14	8	5
MAIN	21	19	16	8	13
NETW	16	19	11	10	7
FAX	15	18	14	15	6

GRADING SCALE

	EFFI	USAB	COMP	COST	REUS
Weig:	26	24	21	15	15
Exce	26	24	21	15	15
Good	20	18	15	11	11
Aver	13	12	10	7	7
Fair	7	6	5	4	4
Weak	0	0	0	0	0

** CONCORDANCE THRESHOLD (P) [0 - 100] :
(NB ... becomes severe as it approaches 100) ? 80

** DISCORDANCE THRESHOLD (Q) [0 - 100] :
(NB ... becomes severe as it approaches 100) ? 65

STEP 4 : EVALUATION OF ALTERNATIVES
Method used : ELECTRE

U ALTERN.EVALUATION: WORKING AREA

	EFFI	USAB	COMP	COST	REUS
SYST	16	18	14	8	5
MAIN	21	19	16	8	13
NETW	16	19	11	10	7
FAX	15	18	14	15	6

GRADING SCALE

	EFFI	USAB	COMP	COST	REUS
Weig:	26	24	21	15	15
Exce	26	24	21	15	15
Good	20	18	15	11	11
Aver	13	12	10	7	7
Fair	7	6	5	4	4
Weak	0	0	0	0	0

P = 80.00 % Q = 65.00 %

MENU

1. CONCORDANCE MATRIX
2. DISCORDANCE MATRIX
3. OUTRANKING MATRIX
4. MODIFY THRESHOLDS
5. EXIT ELECTRE

SELECTION (1-5) ? 1

STEP 4 : EVALUATION OF ALTERNATIVES
Method used : ELECTRE

U ALTERN.EVALUATION: WORKING AREA

	EFFI	USAB	COMP	COST	REUS
SYST	16	18	14	8	5
MAIN	21	19	16	8	13
NETW	16	19	11	10	7
FAX	15	18	14	15	6

GRADING SCALE

	EFFI	USAB	COMP	COST	REUS
Weig:	26	24	21	15	15
Exce	26	24	21	15	15
Good	20	18	15	11	11
Aver	13	12	10	7	7
Fair	7	6	5	4	4
Weak	0	0	0	0	0

P = 80.00 %   Q = 65.00 %

L CONCORDANCE MATRIX

	SYS	MAI	NET	FAX	#CI
SYS	-	15	47	71	0
MAI	100	-	85	85	3
NET	79	38	-	65	0
FAX	74	15	35	-	0

** A Concordance index indicates to what extent an option is better than another in terms of criteria weights.
** The index varies between [0 - 100] the higher the better.
3 indexes are > = 80
** Column #CI indicates the # of indexes satisfying P for each option.

Press RETURN to continue

STEP 4 : EVALUATION OF ALTERNATIVES
Method used : ELECTRE

U ALTERN.EVALUATION: WORKING AREA

	EFFI	USAB	COMP	COST	REUS
SYST	16	18	14	8	5
MAIN	21	19	16	8	13
NETW	16	19	11	10	7
FAX	15	18	14	15	6

GRADING SCALE

	EFFI	USAB	COMP	COST	REUS
Weig:	26	24	21	15	15
Exce	26	24	21	15	15
Good	20	18	15	11	11
Aver	13	12	10	7	7
Fair	7	6	5	4	4
Weak	0	0	0	0	0

P = 80.00 % Q = 65.00 %

MENU

1. CONCORDANCE MATRIX
2. DISCORDANCE MATRIX
3. OUTRANKING MATRIX
4. MODIFY THRESHOLDS
5. EXIT ELECTRE

SELECTION (1-5) ? 2

STEP 4 : EVALUATION OF ALTERNATIVES
Method used : ELECTRE

U ALTERN.EVALUATION: WORKING AREA

	EFFI	USAB	COMP	COST	REUS
SYST	16	18	14	8	5
MAIN	21	19	16	8	13
NETW	16	19	11	10	7
FAX	15	18	14	15	6

GRADING SCALE

	EFFI	USAB	COMP	COST	REUS
Weig:	26	24	21	15	15
Exce	26	24	21	15	15
Good	20	18	15	11	11
Aver	13	12	10	7	7
Fair	7	6	5	4	4
Weak	0	0	0	0	0

P = 80.00 % Q = 65.00 %

L DISCORDANCE MATRIX

	SYS	MAI	NET	FAX	#DI
SYS	-	30	8	26	3
MAI	0	-	8	26	3
NET	11	23	-	19	3
FAX	4	26	4	-	3

** A Discordance index indicates to what extent an option contains a bad element that makes it un-satisfactory
** The index varies between [0 - 100] the lower the better.
12 indexes are < = 65.00
** Column #CI indicates the # of indexes satisfying Q for each option.

Press RETURN to continue

STEP 4 : EVALUATION OF ALTERNATIVES
Method used : ELECTRE

U ALTERN.EVALUATION: WORKING AREA

	EFFI	USAB	COMP	COST	REUS
SYST	16	18	14	8	5
MAIN	21	19	16	8	13
NETW	16	19	11	10	7
FAX	15	18	14	15	6

GRADING SCALE

	EFFI	USAB	COMP	COST	REUS
Weig:	26	24	21	15	15
Exce	26	24	21	15	15
Good	20	18	15	11	11
Aver	13	12	10	7	7
Fair	7	6	5	4	4
Weak	0	0	0	0	0

P = 80.00 % Q = 65.00 %

MENU

1. CONCORDANCE MATRIX
2. DISCORDANCE MATRIX
3. OUTRANKING MATRIX
4. MODIFY THRESHOLDS
5. EXIT ELECTRE

SELECTION (1-5) ? 3

STEP 4 : EVALUATION OF ALTERNATIVES
Method used : ELECTRE

U ALTERN.EVALUATION: WORKING AREA

	EFFI	USAB	COMP	COST	REUS
SYST	16	18	14	8	5
MAIN	21	19	16	8	13
NETW	16	19	11	10	7
FAX	15	18	14	15	6

GRADING SCALE

	EFFI	USAB	COMP	COST	REUS
Weig:	26	24	21	15	15
Exce	26	24	21	15	15
Good	20	18	15	11	11
Aver	13	12	10	7	7
Fair	7	6	5	4	4
Weak	0	0	0	0	0

P = 80.00 % Q = 65.00 %

L OUTRANKING MATRIX

	SYS	MAI	NET	FAX
SYS	-	-	-	-
MAI	*	-	*	*
NET	-	-	-	-
FAX	-	-	-	-

** An Outranking relation * is the one that satisfies both concordance and discordance requirements.

** An - indicates that there is no outranking relations.

Press RETURN to continue

STEP 4 : EVALUATION OF ALTERNATIVES
Method used : ELECTRE

U ALTERN.EVALUATION: WORKING AREA

	EFFI	USAB	COMP	COST	REUS
SYST	16	18	14	8	5
MAIN	21	19	16	8	13
NETW	16	19	11	10	7
FAX	15	18	14	15	6

GRADING SCALE

	EFFI	USAB	COMP	COST	REUS
Weig:	26	24	21	15	15
Exce	26	24	21	15	15
Good	20	18	15	11	11
Aver	13	12	10	7	7
Fair	7	6	5	4	4
Weak	0	0	0	0	0

P = 80.00 % Q = 65.00 %

MENU

1. CONCORDANCE MATRIX
2. DISCORDANCE MATRIX
3. OUTRANKING MATRIX
4. MODIFY THRESHOLDS
5. EXIT ELECTRE

SELECTION (1-5) ? 5

STEP 4 : EVALUATION OF ALTERNATIVES
Method used : ELECTRE

The following person(s) is (are) allowed to read your solution:

DM TWO
DM THREE
DM FOUR

The following person(s) is (are) not allowed to read your solution:

Do you confirm the above lists (Y/N) ?

```
BILLET.DEF                                  DFAS2.GN
Q.DEF                                       POSEY.GN
MONDAY.DEF                                  SUV.GN
QQ.DEF                                      DREW.GN
DSSFINAL.DEF                                WEEK.GN
MAINT.DEF                                   RALPH.GN
REMAP.DEF                                   REMAP.GN
CELLU_CO.DEF                                CELLU_CO.GN
FINAL.DEF                                   CELL_COM.GN
HOLD_ON.DEF                                 HOLD_ON.GN
CELL_COM.DEF                                FINAL.GN

THE NAME OF THE PROBLEM  ?   CELL_COMP_DESIGN

THE NAME OF THE NORM ?   CELL_COMP_DESIGN

YOUR NAME ?  DM TWO

YOUR ID ?    ****

THE METHOD THAT YOU WANT TO USE  ?           A

STEP 4 : INDIVIDUAL EVALUATION OF ALTERNATIVES
Identification of the problem   METHODS : AHP, ELECTRE, DIRECT
```

```
PAIRWISE COMPARISION                                       PRIORITY VECTOR

        SYSTE MAINT NETWO FAX
SYSTE                                                      SYSTEM_INTRE °      °
MAINT                                                      MAINTAINABIL °      °
NETWO                                                      NETWORK      °      °
FAX                                                        FAX          °      °


 Is SYSTEM_INTREFACE better than  MAINTAINABILITY (Y/N/=)     n
 How many times is MAINTAINABILITY better than  SYSTEM_INTREFA1.25
 ( See note below )
"NOTE": Be as accurate as possible -- any # greater than 1
       e.g. 1.2 or 1.4
A possible scale for inexact is :
    1.25 = weakly important than , 1.50 = strongly more important than
    1.75 = very strongly more imp.than 2.0 = absolutely more imp. than


STEP 4 : INDIVIDUAL EVALUATION OF ALTERNATIVES
Evaluation of Alternatives According to Criterion EFFICIENCY   Method: AHP
```

PAIRWISE COMPARISION

	SYSTE	MAINT	NETWO	FAX
SYSTE	1.00	0.80	1.50	
MAINT	1.25	1.00		
NETWO	0.67		1.00	
FAX				1.00

PRIORITY VECTOR

SYSTEM_INTRE	°	°
MAINTAINABIL	°	°
NETWORK	°	°
FAX	°	°

Is SYSTEM_INTREFACE better than FAX (Y/N/=) ? y
How many times is SYSTEM_INTREFACE better than FAX ? 1.33
(See note below)
"NOTE": Be as accurate as possible -- any # greater than 1
e.g. 1.2 or 1.4
A possible scale for inexact is :
1.25 = weakly important than , 1.50 = strongly more important than
1.75 = very strongly more imp.than 2.0 = absolutely more imp. than

STEP 4 : INDIVIDUAL EVALUATION OF ALTERNATIVES
Evaluation of Alternatives According to Criterion EFFICIENCY Method: AHP

PAIRWISE COMPARISION

	SYSTE	MAINT	NETWO	FAX
SYSTE	1.00	0.80	1.50	1.33
MAINT	1.25	1.00		
NETWO	0.67		1.00	
FAX	0.75			1.00

PRIORITY VECTOR

SYSTEM_INTRE	°	°
MAINTAINABIL	°	°
NETWORK	°	°
FAX	°	°

Is MAINTAINABILITY better than NETWORK (Y/N/=) ? y
How many times is MAINTAINABILITY better than NETWORK ? 1.7
(See note below)
"NOTE": Be as accurate as possible -- any # greater than 1
e.g. 1.2 or 1.4
A possible scale for inexact is :
1.25 = weakly important than , 1.50 = strongly more important than
1.75 = very strongly more imp.than 2.0 = absolutely more imp. than

STEP 4 : INDIVIDUAL EVALUATION OF ALTERNATIVES
Evaluation of Alternatives According to Criterion EFFICIENCY Method: AHP

PAIRWISE COMPARISION

	SYSTE	MAINT	NETWO	FAX
SYSTE	1.00	0.80	1.50	1.33
MAINT	1.25	1.00	1.70	
NETWO	0.67	0.59	1.00	
FAX	0.75			1.00

PRIORITY VECTOR

SYSTEM_INTRE	°	°
MAINTAINABIL	°	°
NETWORK	°	°
FAX	°	°

Is MAINTAINABILITY better than FAX (Y/N/=) ? y
How many times is MAINTAINABILITY better than FAX ? 1.25
(See note below)
"NOTE": Be as accurate as possible -- any # greater than 1
e.g. 1.2 or 1.4
A possible scale for inexact is :
1.25 = weakly important than , 1.50 = strongly more important than
1.75 = very strongly more imp.than 2.0 = absolutely more imp. than

STEP 4 : INDIVIDUAL EVALUATION OF ALTERNATIVES
Evaluation of Alternatives According to Criterion EFFICIENCY Method: AHP

PAIRWISE COMPARISION

	SYSTE	MAINT	NETWO	FAX
SYSTE	1.00	0.80	1.50	1.33
MAINT	1.25	1.00	1.70	1.25
NETWO	0.67	0.59	1.00	
FAX	0.75	0.80		1.00

PRIORITY VECTOR

SYSTEM_INTRE	°	°
MAINTAINABIL	°	°
NETWORK	°	°
FAX	°	°

Is NETWORK better than FAX (Y/N/=) ? y
How many times is NETWORK better than FAX ? 1.25
(See note below)
"NOTE": Be as accurate as possible -- any # greater than 1
e.g. 1.2 or 1.4
A possible scale for inexact is :
1.25 = weakly important than , 1.50 = strongly more important than
1.75 = very strongly more imp.than 2.0 = absolutely more imp. than

STEP 4 : INDIVIDUAL EVALUATION OF ALTERNATIVES
Evaluation of Alternatives According to Criterion EFFICIENCY Method: AHP

PAIRWISE COMPARISION

	SYSTE	MAINT	NETWO	FAX
SYSTE	1.00	0.80	1.50	1.33
MAINT	1.25	1.00	1.70	1.25
NETWO	0.67	0.59	1.00	1.25
FAX	0.75	0.80	0.80	1.00

PRIORITY VECTOR

MAINTAINABIL	°0.314 °
SYSTEM_INTRE	°0.275 °
NETWORK	°0.206 °
FAX	°0.205 °

** LAMDA MAX = 4.03
CONSISTENCY INDEX = 0.01
RANDOMIZED INDEX = 0.90
CONSISTENCY RATIO = 0.01

** Your Evaluation is More or Less Consistent.

MAI	SYS	NET	FAX
0.31	0.27	0.21	0.21

DO YOU WANT TO MODIFY THE DATA (Y/N) ?

STEP 4 : INDIVIDUAL EVALUATION OF ALTERNATIVES
Evaluation of Alternatives According to Criterion EFFICIENCY Method: AHP

PAIRWISE COMPARISION

PRIORITY VECTOR

```
        SYSTE MAINT NETWO FAX
SYSTE
MAINT
NETWO
FAX
```

```
SYSTEM_INTRE °       °
MAINTAINABIL °       °
NETWORK      °       °
FAX          °       °
```

```
 Is SYSTEM_INTREFACE better than  MAINTAINABILITY (Y/N/=)     y
 How many times is SYSTEM_INTREFACE better than  MAINTAINABILI1.5
 ( See note below )
"NOTE": Be as accurate as possible -- any # greater than 1
       e.g. 1.2 or 1.4
A possible scale for inexact is :
    1.25 = weakly important than , 1.50 = strongly more important than
    1.75 = very strongly more imp.than 2.0 = absolutely more imp. than
```

STEP 4 : INDIVIDUAL EVALUATION OF ALTERNATIVES

Evaluation of Alternatives According to Criterion COST   Method: AHP

PAIRWISE COMPARISION

	SYSTE	MAINT	NETWO	FAX
SYSTE	1.00	1.50		
MAINT	0.67	1.00		
NETWO			1.00	
FAX				1.00

PRIORITY VECTOR

SYSTEM_INTRE	°	°
MAINTAINABIL	°	°
NETWORK	°	°
FAX	°	°

Is SYSTEM_INTREFACE better than NETWORK (Y/N/=) ? y
How many times is SYSTEM_INTREFACE better than NETWORK ? 1.75
(See note below)
"NOTE": Be as accurate as possible -- any # greater than 1
e.g. 1.2 or 1.4
A possible scale for inexact is :
1.25 = weakly important than , 1.50 = strongly more important than
1.75 = very strongly more imp.than 2.0 = absolutely more imp. than

STEP 4 : INDIVIDUAL EVALUATION OF ALTERNATIVES
Evaluation of Alternatives According to Criterion COST Method: AHP

PAIRWISE COMPARISION

	SYSTE	MAINT	NETWO	FAX
SYSTE	1.00	1.50	1.75	
MAINT	0.67	1.00		
NETWO	0.57		1.00	
FAX				1.00

PRIORITY VECTOR

SYSTEM_INTRE	°	°
MAINTAINABIL	°	°
NETWORK	°	°
FAX	°	°

Is SYSTEM_INTREFACE better than FAX (Y/N/=) ? y

How many times is SYSTEM_INTREFACE better than FAX ? 1.25

(See note below)

"NOTE": Be as accurate as possible -- any # greater than 1
e.g. 1.2 or 1.4

A possible scale for inexact is :

1.25 = weakly important than , 1.50 = strongly more important than
1.75 = very strongly more imp.than 2.0 = absolutely more imp. than

STEP 4 : INDIVIDUAL EVALUATION OF ALTERNATIVES

Evaluation of Alternatives According to Criterion COST Method: AHP

PAIRWISE COMPARISION

	SYSTE	MAINT	NETWO	FAX
SYSTE	1.00	1.50	1.75	1.25
MAINT	0.67	1.00		
NETWO	0.57		1.00	
FAX	0.80			1.00

PRIORITY VECTOR

SYSTEM_INTRE	°	°
MAINTAINABIL	°	°
NETWORK	°	°
FAX	°	°

Is MAINTAINABILITY better than NETWORK (Y/N/=) ? y
How many times is MAINTAINABILITY better than NETWORK ? 1.34
(See note below)
"NOTE": Be as accurate as possible -- any # greater than 1
e.g. 1.2 or 1.4
A possible scale for inexact is :
1.25 = weakly important than , 1.50 = strongly more important than
1.75 = very strongly more imp.than 2.0 = absolutely more imp. than

STEP 4 : INDIVIDUAL EVALUATION OF ALTERNATIVES
Evaluation of Alternatives According to Criterion COST Method: AHP

PAIRWISE COMPARISION

	SYSTE	MAINT	NETWO	FAX
SYSTE	1.00	1.50	1.75	1.25
MAINT	0.67	1.00	1.34	
NETWO	0.57	0.75	1.00	
FAX	0.80			1.00

PRIORITY VECTOR

SYSTEM_INTRE	°	°
MAINTAINABIL	°	°
NETWORK	°	°
FAX	°	°

Is MAINTAINABILITY better than FAX (Y/N/=) ? n
How many times is FAX better than MAINTAINABILITY ? 1.3
(See note below)
"NOTE": Be as accurate as possible -- any # greater than 1
e.g. 1.2 or 1.4
A possible scale for inexact is :
1.25 = weakly important than , 1.50 = strongly more important than
1.75 = very strongly more imp.than 2.0 = absolutely more imp. than

STEP 4 : INDIVIDUAL EVALUATION OF ALTERNATIVES
Evaluation of Alternatives According to Criterion COST Method: AHP

PAIRWISE COMPARISION

	SYSTE	MAINT	NETWO	FAX
SYSTE	1.00	1.50	1.75	1.25
MAINT	0.67	1.00	1.34	0.77
NETWO	0.57	0.75	1.00	
FAX	0.80	1.30		1.00

PRIORITY VECTOR

SYSTEM_INTRE	°	°
MAINTAINABIL	°	°
NETWORK	°	°
FAX	°	°

Is NETWORK better than FAX (Y/N/=) ? y
How many times is NETWORK better than FAX ? 1.4
(See note below)
"NOTE": Be as accurate as possible -- any # greater than 1
e.g. 1.2 or 1.4
A possible scale for inexact is :
1.25 = weakly important than , 1.50 = strongly more important than
1.75 = very strongly more imp.than 2.0 = absolutely more imp. than

STEP 4 : INDIVIDUAL EVALUATION OF ALTERNATIVES
Evaluation of Alternatives According to Criterion COST Method: AHP

PAIRWISE COMPARISION

	SYSTE	MAINT	NETWO	FAX
SYSTE	1.00	1.50	1.75	1.25
MAINT	0.67	1.00	1.34	0.77
NETWO	0.57	0.75	1.00	1.40
FAX	0.80	1.30	0.71	1.00

PRIORITY VECTOR

SYSTEM_INTRE	°0.327 °
FAX	°0.230 °
MAINTAINABIL	°0.224 °
NETWORK	°0.219 °

** LAMDA MAX = 4.08
CONSISTENCY INDEX = 0.03
RANDOMIZED INDEX = 0.90
CONSISTENCY RATIO = 0.03

** Your Evaluation is More
or Less Consistent.

SYS	FAX	MAI	NET
0.33	0.23	0.22	0.22

DO YOU WANT TO MODIFY THE DATA (Y/N) ?

STEP 4 : INDIVIDUAL EVALUATION OF ALTERNATIVES
Evaluation of Alternatives According to Criterion COST Method: AHP

```
PAIRWISE COMPARISION                                          PRIORITY VECTOR

        SYSTE MAINT NETWO FAX
SYSTE                                                         SYSTEM_INTRE °      °
MAINT                                                         MAINTAINABIL °      °
NETWO                                                         NETWORK      °      °
FAX                                                           FAX          °      °



 Is SYSTEM_INTREFACE better than  MAINTAINABILITY (Y/N/=)      y
 How many times is SYSTEM_INTREFACE better than  MAINTAINABILI1.6
 ( See note below )
"NOTE": Be as accurate as possible -- any # greater than 1
        e.g. 1.2 or 1.4
A possible scale for inexact is :
    1.25 = weakly important than , 1.50 = strongly more important than
    1.75 = very strongly more imp.than 2.0 = absolutely more imp. than


STEP 4 : INDIVIDUAL EVALUATION OF ALTERNATIVES
Evaluation of Alternatives According to Criterion USABILITY   Method: AHP
```

PAIRWISE COMPARISION

	SYSTE	MAINT	NETWO	FAX
SYSTE	1.00	1.60		
MAINT	0.63	1.00		
NETWO			1.00	
FAX				1.00

PRIORITY VECTOR

SYSTEM_INTRE	°	°
MAINTAINABIL	°	°
NETWORK	°	°
FAX	°	°

```
 Is SYSTEM_INTREFACE better than  NETWORK (Y/N/=)          ?  y
 How many times is SYSTEM_INTREFACE better than  NETWORK  ?   1.8
 ( See note below )
"NOTE": Be as accurate as possible -- any # greater than 1
       e.g. 1.2 or 1.4
 A possible scale for inexact is :
    1.25 = weakly important than , 1.50 = strongly more important than
    1.75 = very strongly more imp.than 2.0 = absolutely more imp. than
```

STEP 4 : INDIVIDUAL EVALUATION OF ALTERNATIVES

Evaluation of Alternatives According to Criterion USABILITY   Method: AHP

PAIRWISE COMPARISION

	SYSTE	MAINT	NETWO	FAX
SYSTE	1.00	1.60	1.80	
MAINT	0.63	1.00		
NETWO	0.56		1.00	
FAX				1.00

PRIORITY VECTOR

SYSTEM_INTRE	°	°
MAINTAINABIL	°	°
NETWORK	°	°
FAX	°	°

Is SYSTEM_INTREFACE better than FAX (Y/N/=) ? y
How many times is SYSTEM_INTREFACE better than FAX ? 1.75
(See note below)
"NOTE": Be as accurate as possible -- any # greater than 1
e.g. 1.2 or 1.4
A possible scale for inexact is :
1.25 = weakly important than , 1.50 = strongly more important than
1.75 = very strongly more imp.than 2.0 = absolutely more imp. than

STEP 4 : INDIVIDUAL EVALUATION OF ALTERNATIVES
Evaluation of Alternatives According to Criterion USABILITY Method: AHP

PAIRWISE COMPARISION

	SYSTE	MAINT	NETWO	FAX
SYSTE	1.00	1.60	1.80	1.75
MAINT	0.63	1.00		
NETWO	0.56		1.00	
FAX	0.57			1.00

PRIORITY VECTOR

SYSTEM_INTRE	°	°
MAINTAINABIL	°	°
NETWORK	°	°
FAX	°	°

Is MAINTAINABILITY better than NETWORK (Y/N/=) ? n
How many times is NETWORK better than MAINTAINABILITY ? 1.4
(See note below)
"NOTE": Be as accurate as possible -- any # greater than 1
e.g. 1.2 or 1.4
A possible scale for inexact is :
1.25 = weakly important than , 1.50 = strongly more important than
1.75 = very strongly more imp.than 2.0 = absolutely more imp. than

STEP 4 : INDIVIDUAL EVALUATION OF ALTERNATIVES
Evaluation of Alternatives According to Criterion USABILITY Method: AHP

PAIRWISE COMPARISION

	SYSTE	MAINT	NETWO	FAX
SYSTE	1.00	1.60	1.80	1.75
MAINT	0.63	1.00	0.71	
NETWO	0.56	1.40	1.00	
FAX	0.57			1.00

PRIORITY VECTOR

SYSTEM_INTRE	°	°
MAINTAINABIL	°	°
NETWORK	°	°
FAX	°	°

Is MAINTAINABILITY better than FAX (Y/N/=) ? n
How many times is FAX better than MAINTAINABILITY ? 1.67
(See note below)
"NOTE": Be as accurate as possible -- any # greater than 1
e.g. 1.2 or 1.4
A possible scale for inexact is :
1.25 = weakly important than , 1.50 = strongly more important than
1.75 = very strongly more imp.than 2.0 = absolutely more imp. than

STEP 4 : INDIVIDUAL EVALUATION OF ALTERNATIVES
Evaluation of Alternatives According to Criterion USABILITY Method: AHP

PAIRWISE COMPARISION

	SYSTE	MAINT	NETWO	FAX
SYSTE	1.00	1.60	1.80	1.75
MAINT	0.63	1.00	0.71	0.60
NETWO	0.56	1.40	1.00	
FAX	0.57	1.67		1.00

PRIORITY VECTOR

SYSTEM_INTRE	°	°
MAINTAINABIL	°	°
NETWORK	°	°
FAX	°	°

Is NETWORK better than FAX (Y/N/=) ? y

How many times is NETWORK better than FAX ? 1.54

(See note below)

"NOTE": Be as accurate as possible -- any # greater than 1
e.g. 1.2 or 1.4

A possible scale for inexact is :
1.25 = weakly important than , 1.50 = strongly more important than
1.75 = very strongly more imp.than 2.0 = absolutely more imp. than

STEP 4 : INDIVIDUAL EVALUATION OF ALTERNATIVES

Evaluation of Alternatives According to Criterion USABILITY Method: AHP

PAIRWISE COMPARISION

	SYSTE	MAINT	NETWO	FAX
SYSTE	1.00	1.60	1.80	1.75
MAINT	0.63	1.00	0.71	0.60
NETWO	0.56	1.40	1.00	1.54
FAX	0.57	1.67	0.65	1.00

PRIORITY VECTOR

SYSTEM_INTRE	°0.360 °
NETWORK	°0.252 °
FAX	°0.215 °
MAINTAINABIL	°0.174 °

** LAMDA MAX = 4.07
CONSISTENCY INDEX = 0.02
RANDOMIZED INDEX = 0.90
CONSISTENCY RATIO = 0.03

** Your Evaluation is More or Less Consistent.

SYS	NET	FAX	MAI
0.36	0.25	0.21	0.17

DO YOU WANT TO MODIFY THE DATA (Y/N) ?

STEP 4 : INDIVIDUAL EVALUATION OF ALTERNATIVES
Evaluation of Alternatives According to Criterion USABILITY Method: AHP

PAIRWISE COMPARISION

	SYSTE	MAINT	NETWO	FAX
SYSTE	1.00	1.40	0.72	1.76
MAINT	0.71	1.00	0.63	1.25
NETWO	1.38	1.60	1.00	1.53
FAX	0.57	0.80	0.65	1.00

PRIORITY VECTOR

NETWORK	°0.330 °
SYSTEM_INTRE	°0.281 °
MAINTAINABIL	°0.209 °
FAX	°0.180 °

** LAMDA MAX = 4.02
CONSISTENCY INDEX = 0.01
RANDOMIZED INDEX = 0.90
CONSISTENCY RATIO = 0.01

** Your Evaluation is More or Less Consistent.

NET	SYS	MAI	FAX
0.33	0.28	0.21	0.18

DO YOU WANT TO MODIFY THE DATA (Y/N) ?

STEP 4 : INDIVIDUAL EVALUATION OF ALTERNATIVES
Evaluation of Alternatives According to Criterion COMPATIBILITY Method: AHP

PAIRWISE COMPARISION

	SYSTE	MAINT	NETWO	FAX
SYSTE	1.00	0.53	1.50	1.62
MAINT	1.90	1.00	1.75	1.80
NETWO	0.67	0.57	1.00	1.30
FAX	0.62	0.56	0.77	1.00

PRIORITY VECTOR

MAINTAINABIL	°0.375 °
SYSTEM_INTRE	°0.255 °
NETWORK	°0.199 °
FAX	°0.171 °

** LAMDA MAX = 4.04
CONSISTENCY INDEX = 0.01
RANDOMIZED INDEX = 0.90
CONSISTENCY RATIO = 0.01

** Your Evaluation is More
or Less Consistent.

MAI	SYS	NET	FAX
0.38	0.25	0.20	0.17

DO YOU WANT TO MODIFY THE DATA (Y/N) ?

STEP 4 : INDIVIDUAL EVALUATION OF ALTERNATIVES
Evaluation of Alternatives According to Criterion REUSABILITY   Method: AHP

FINAL SOLUTION

SYS	MAI	NET	FAX
0.30	0.25	0.24	0.20

Press any key to continue

STEP 4 : INDIVIDUAL EVALUATION OF ALTERNATIVES
Final Result

The following person(s) is (are) allowed to read your solution:

DM ONE
DM THREE
DM FOUR

The following person(s) is (are) not allowed to read your solution:

Do you confirm the above lists (Y/N) ?

```
BILLET.DEF                                  DFAS2.GN
Q.DEF                                       POSEY.GN
MONDAY.DEF                                  SUV.GN
QQ.DEF                                      DREW.GN
DSSFINAL.DEF                                WEEK.GN
MAINT.DEF                                   RALPH.GN
REMAP.DEF                                   REMAP.GN
CELLU_CO.DEF                                CELLU_CO.GN
FINAL.DEF                                   CELL_COM.GN
HOLD_ON.DEF                                 HOLD_ON.GN
CELL_COM.DEF                                FINAL.GN

THE NAME OF THE PROBLEM  ?   CELL_COMP_DESIGN

THE NAME OF THE NORM ?   CELL_COMP_DESIGN

YOUR NAME ?  DM THREE

YOUR ID ?     ****

THE METHOD THAT YOU WANT TO USE  ?            D

STEP 4 : INDIVIDUAL EVALUATION OF ALTERNATIVES
Identification of the problem   METHODS : AHP, ELECTRE, DIRECT
```

A ALTERN. EVALUATION: WORKING AREA

	SYSTE	MAINT	NETWO	FAX
EFFIC	5.00	3.00	8.00	6.00
COST				
USABI				
COMPA				
REUSA				

B PRIORITY VECTOR

NETWORK	°0.364 °
FAX	°0.273 °
SYSTEM_INTRE	°0.227 °
MAINTAINABIL	°0.136 °

Do you want to modify the weights (Y/N) ?

NET	FAX	SYS	MAI
0.36	0.27	0.23	0.14

STEP 4 : INDIVIDUAL EVALUATION OF ALTERNATIVES
Method used : Direct input

A ALTERN. EVALUATION: WORKING AREA

	SYSTE	MAINT	NETWO	FAX
EFFIC	5.00	3.00	8.00	6.00
COST	7.00	9.00	6.00	
USABI				
COMPA				
REUSA				

B PRIORITY VECTOR

NETWORK	°0.364 °
FAX	°0.273 °
SYSTEM_INTRE	°0.227 °
MAINTAĪNABIL	°0.136 °

** EVALUATE ALTERNATIVE ACCORDING TO CRITERIA COST :

1 - For Alternative SYSTEM_INTREF any value between 0 and 10 ? 7
2 - For Alternative MAINTAĪNABILI any value between 0 and 10 ? 9
3 - For Alternative NETWORK any value between 0 and 10 ? 6
4 - For Alternative FAX any value between 0 and 10 ? 4

STEP 4 : INDIVIDUAL EVALUATION OF ALTERNATIVES
Method used : Direct input

A ALTERN. EVALUATION: WORKING AREA

	SYSTE	MAINT	NETWO	FAX
EFFIC	5.00	3.00	8.00	6.00
COST	7.00	9.00	6.00	4.00
USABI				
COMPA				
REUSA				

B PRIORITY VECTOR

MAINTAINABIL	°0.346 °
SYSTEM_INTRE	°0.269 °
NETWORK	°0.231 °
FAX	°0.154 °

Do you want to modify the weights (Y/N) ?

MAI	SYS	NET	FAX
0.35	0.27	0.23	0.15

STEP 4 : INDIVIDUAL EVALUATION OF ALTERNATIVES
Method used : Direct input

A ALTERN. EVALUATION: WORKING AREA

	SYSTE	MAINT	NETWO	FAX
EFFIC	5.00	3.00	8.00	6.00
COST	7.00	9.00	6.00	4.00
USABI	9.00	5.00	7.00	
COMPA				
REUSA				

B PRIORITY VECTOR

MAINTAINABIL	°0.346 °
SYSTEM_INTRE	°0.269 °
NETWORK	°0.231 °
FAX	°0.154 °

** EVALUATE ALTERNATIVE ACCORDING TO CRITERIA USABILITY :

1 - For Alternative SYSTEM_INTREF any value between 0 and 10 ? 9
2 - For Alternative MAINTAINABILI any value between 0 and 10 ? 5
3 - For Alternative NETWORK any value between 0 and 10 ? 7
4 - For Alternative FAX any value between 0 and 10 ? 7

STEP 4 : INDIVIDUAL EVALUATION OF ALTERNATIVES
Method used : Direct input

A ALTERN. EVALUATION: WORKING AREA

	SYSTE	MAINT	NETWO	FAX
EFFIC	5.00	3.00	8.00	6.00
COST	7.00	9.00	6.00	4.00
USABI	9.00	5.00	7.00	7.00
COMPA				
REUSA				

B PRIORITY VECTOR

SYSTEM_INTRE	°0.321 °
NETWORK	°0.250 °
FAX	°0.250 °
MAINTAINABIL	°0.179 °

Do you want to modify the weights (Y/N) ? n

SYS	NET	FAX	MAI
0.32	0.25	0.25	0.18

STEP 4 : INDIVIDUAL EVALUATION OF ALTERNATIVES
Method used : Direct input

A ALTERN. EVALUATION: WORKING AREA

	SYSTE	MAINT	NETWO	FAX
EFFIC	5.00	3.00	8.00	6.00
COST	7.00	9.00	6.00	4.00
USABI	9.00	5.00	7.00	7.00
COMPA	10.00	4.00	7.00	
REUSA				

B PRIORITY VECTOR

SYSTEM_INTRE	°0.321 °
NETWORK	°0.250 °
FAX	°0.250 °
MAINTAINABIL	°0.179 °

** EVALUATE ALTERNATIVE ACCORDING TO CRITERIA COMPATIBILITY :

1 - For Alternative SYSTEM_INTREF any value between 0 and 10 ? 10
2 - For Alternative MAINTAINABILI any value between 0 and 10 ? 4
3 - For Alternative NETWORK any value between 0 and 10 ? 7
4 - For Alternative FAX any value between 0 and 10 ? 8

STEP 4 : INDIVIDUAL EVALUATION OF ALTERNATIVES
Method used : Direct input

A ALTERN. EVALUATION: WORKING AREA

	SYSTE	MAINT	NETWO	FAX
EFFIC	5.00	3.00	8.00	6.00
COST	7.00	9.00	6.00	4.00
USABI	9.00	5.00	7.00	7.00
COMPA	10.00	4.00	7.00	8.00
REUSA				

B PRIORITY VECTOR

SYSTEM_INTRE	°0.345 °
FAX	°0.276 °
NETWORK	°0.241 °
MAINTAINABIL	°0.138 °

Do you want to modify the weights (Y/N) ?

SYS	FAX	NET	MAI
0.34	0.28	0.24	0.14

STEP 4 : INDIVIDUAL EVALUATION OF ALTERNATIVES
Method used : Direct input

A ALTERN. EVALUATION: WORKING AREA

	SYSTE	MAINT	NETWO	FAX
EFFIC	5.00	3.00	8.00	6.00
COST	7.00	9.00	6.00	4.00
USABI	9.00	5.00	7.00	7.00
COMPA	10.00	4.00	7.00	8.00
REUSA	5.00	8.00	7.00	

B PRIORITY VECTOR

SYSTEM_INTRE	°0.345 °
FAX	°0.276 °
NETWORK	°0.241 °
MAINTAINABIL	°0.138 °

** EVALUATE ALTERNATIVE ACCORDING TO CRITERIA REUSABILITY :

1 - For Alternative SYSTEM_INTREF any value between 0 and 10 ? 5
2 - For Alternative MAINTAINABILI any value between 0 and 10 ? 8
3 - For Alternative NETWORK any value between 0 and 10 ? 7
4 - For Alternative FAX any value between 0 and 10 ? 4

STEP 4 : INDIVIDUAL EVALUATION OF ALTERNATIVES
Method used : Direct input

A ALTERN. EVALUATION: WORKING AREA

	SYSTE	MAINT	NETWO	FAX
EFFIC	5.00	3.00	8.00	6.00
COST	7.00	9.00	6.00	4.00
USABI	9.00	5.00	7.00	7.00
COMPA	10.00	4.00	7.00	8.00
REUSA	5.00	8.00	7.00	4.00

B PRIORITY VECTOR

MAINTAINABIL	°0.333 °
NETWORK	°0.292 °
SYSTEM_INTRE	°0.208 °
FAX	°0.167 °

Do you want to modify the weights (Y/N) ?

MAI	NET	SYS	FAX
0.33	0.29	0.21	0.17

STEP 4 : INDIVIDUAL EVALUATION OF ALTERNATIVES
Method used : Direct input

FINAL SOLUTION

NET	SYS	FAX	MAI
0.28	0.28	0.23	0.22

Press any key to continue

STEP 4 : INDIVIDUAL EVALUATION OF ALTERNATIVES
Final Result

FINAL SOLUTION FOR GROUP EVALUATION:

Alternatives	Direct	AHP
SYSTEM_INTREFACE	0.28	0.30
MAINTAINABILITY	0.22	0.25
NETWORK	0.28	0.24
FAX	0.23	0.20

(1) Sum of outranking relations
(2) Additive utility formula

Which Method do you want to choose? A

```
BILLET.DEF                                   DFAS2.GN
Q.DEF                                        POSEY.GN
MONDAY.DEF                                   SUV.GN
QQ.DEF                                       DREW.GN
DSSFINAL.DEF                                 WEEK.GN
MAINT.DEF                                    RALPH.GN
REMAP.DEF                                    REMAP.GN
CELLU_CO.DEF                                 CELLU_CO.GN
FINAL.DEF                                    CELL_COM.GN
HOLD_ON.DEF                                  HOLD_ON.GN
CELL_COM.DEF                                 FINAL.GN

THE NAME OF THE PROBLEM  ?   CELL_COMP_DESIGN

THE NAME OF THE NORM ?   CELL_COMP_DESIGN

YOUR NAME ?  DM FOUR

YOUR ID ?    ****

THE METHOD THAT YOU WANT TO USE  ?           D

STEP 4 : INDIVIDUAL EVALUATION OF ALTERNATIVES
Identification of the problem   METHODS : AHP, ELECTRE, DIRECT
```

A ALTERN. EVALUATION: WORKING AREA

	SYSTE	MAINT	NETWO	FAX
COST	5.00	3.00	7.00	
USABI				
REUSA				
COMPA				
EFFIC				

B PRIORITY VECTOR

SYSTEM_INTRE	°	°
MAINTAINABIL	°	°
NETWORK	°	°
FAX	°	°

** EVALUATE ALTERNATIVE ACCORDING TO CRITERIA COST :

1 - For Alternative SYSTEM_INTREF any value between 0 and 10 ? 5
2 - For Alternative MAINTAINABILI any value between 0 and 10 ? 3
3 - For Alternative NETWORK any value between 0 and 10 ? 7
4 - For Alternative FAX any value between 0 and 10 ? 8

STEP 4 : INDIVIDUAL EVALUATION OF ALTERNATIVES
Method used : Direct input

A ALTERN. EVALUATION: WORKING AREA

	SYSTE	MAINT	NETWO	FAX
COST	5.00	3.00	7.00	8.00
USABI				
REUSA				
COMPA				
EFFIC				

B PRIORITY VECTOR

FAX	°0.348 °
NETWORK	°0.304 °
SYSTEM_INTRE	°0.217 °
MAINTAINABIL	°0.130 °

Do you want to modify the weights (Y/N) ?

FAX	NET	SYS	MAI
0.35	0.30	0.22	0.13

STEP 4 : INDIVIDUAL EVALUATION OF ALTERNATIVES
Method used : Direct input

A ALTERN. EVALUATION: WORKING AREA

	SYSTE	MAINT	NETWO	FAX
COST	5.00	3.00	7.00	8.00
USABI	8.00	4.00	9.00	
REUSA				
COMPA				
EFFIC				

B PRIORITY VECTOR

FAX	°0.348 °
NETWORK	°0.304 °
SYSTEM_INTRE	°0.217 °
MAINTAĪNABIL	°0.130 °

** EVALUATE ALTERNATIVE ACCORDING TO CRITERIA USABILITY :

1 - For Alternative SYSTEM_INTREF any value between 0 and 10 ? 8
2 - For Alternative MAINTAĪNABILI any value between 0 and 10 ? 4
3 - For Alternative NETWORK any value between 0 and 10 ? 9
4 - For Alternative FAX any value between 0 and 10 ? 6

STEP 4 : INDIVIDUAL EVALUATION OF ALTERNATIVES
Method used : Direct input

A ALTERN. EVALUATION: WORKING AREA

	SYSTE	MAINT	NETWO	FAX
COST	5.00	3.00	7.00	8.00
USABI	8.00	4.00	9.00	6.00
REUSA				
COMPA				
EFFIC				

B PRIORITY VECTOR

NETWORK	°0.333 °
SYSTEM_INTRE	°0.296 °
FAX	°0.222 °
MAINTAINABIL	°0.148 °

Do you want to modify the weights (Y/N) ?

NET	SYS	FAX	MAI
0.33	0.30	0.22	0.15

STEP 4 : INDIVIDUAL EVALUATION OF ALTERNATIVES
Method used : Direct input

A ALTERN. EVALUATION: WORKING AREA

	SYSTE	MAINT	NETWO	FAX
COST	5.00	3.00	7.00	8.00
USABI	8.00	4.00	9.00	6.00
REUSA	7.00	9.00	5.00	
COMPA				
EFFIC				

B PRIORITY VECTOR

NETWORK	°0.333 °
SYSTEM-INTER	°0.296 °
FAX	°0.222 °
MAINTAINABIL	°0.148 °

** EVALUATE ALTERNATIVE ACCORDING TO CRITERIA REUSABILITY :

1 - For Alternative SYSTEM-INTERF any value between 0 and 10 ? 7
2 - For Alternative MAINTAINABILI any value between 0 and 10 ? 9
3 - For Alternative NETWORK any value between 0 and 10 ? 5
4 - For Alternative FAX any value between 0 and 10 ? 5

STEP 4 : INDIVIDUAL EVALUATION OF ALTERNATIVES
Method used : Direct input

A ALTERN. EVALUATION: WORKING AREA

	SYSTE	MAINT	NETWO	FAX
COST	5.00	3.00	7.00	8.00
USABI	8.00	4.00	9.00	6.00
REUSA	7.00	9.00	5.00	5.00
COMPA				
EFFIC				

B PRIORITY VECTOR

MAINTAINABIL	°0.346 °
SYSTEM_INTRE	°0.269 °
NETWORK	°0.192 °
FAX	°0.192 °

Do you want to modify the weights (Y/N) ?

MAI	SYS	NET	FAX
0.35	0.27	0.19	0.19

STEP 4 : INDIVIDUAL EVALUATION OF ALTERNATIVES
Method used : Direct input

A ALTERN. EVALUATION: WORKING AREA

	SYSTE	MAINT	NETWO	FAX
COST	5.00	3.00	7.00	8.00
USABI	8.00	4.00	9.00	6.00
REUSA	7.00	9.00	5.00	5.00
COMPA	6.00	10.00	7.00	
EFFIC				

B PRIORITY VECTOR

MAINTAINABIL	°0.346 °
SYSTEM_INTRE	°0.269 °
NETWORK	°0.192 °
FAX	°0.192 °

** EVALUATE ALTERNATIVE ACCORDING TO CRITERIA COMPATIBILITY :

1 - For Alternative SYSTEM_INTREF any value between 0 and 10 ? 6
2 - For Alternative MAINTAINABILI any value between 0 and 10 ? 10
3 - For Alternative NETWORK any value between 0 and 10 ? 7
4 - For Alternative FAX any value between 0 and 10 ? 3

STEP 4 : INDIVIDUAL EVALUATION OF ALTERNATIVES
Method used : Direct input

A ALTERN. EVALUATION: WORKING AREA

	SYSTE	MAINT	NETWO	FAX
COST	5.00	3.00	7.00	8.00
USABI	8.00	4.00	9.00	6.00
REUSA	7.00	9.00	5.00	5.00
COMPA	6.00	10.00	7.00	3.00
EFFIC				

B PRIORITY VECTOR

MAINTAINABIL	°0.385 °
NETWORK	°0.269 °
SYSTEM_INTRE	°0.231 °
FAX	°0.115 °

Do you want to modify the weights (Y/N) ?

MAI	NET	SYS	FAX
0.38	0.27	0.23	0.12

STEP 4 : INDIVIDUAL EVALUATION OF ALTERNATIVES
Method used : Direct input

A ALTERN. EVALUATION: WORKING AREA

	SYSTE	MAINT	NETWO	FAX
COST	5.00	3.00	7.00	8.00
USABI	8.00	4.00	9.00	6.00
REUSA	7.00	9.00	5.00	5.00
COMPA	6.00	10.00	7.00	3.00
EFFIC	10.00	4.00	8.00	

B PRIORITY VECTOR

MAINTAINABIL	°0.385 °
NETWORK	°0.269 °
SYSTEM_INTRE	°0.231 °
FAX	°0.115 °

** EVALUATE ALTERNATIVE ACCORDING TO CRITERIA EFFICIENCY :

1 - For Alternative SYSTEM_INTREF any value between 0 and 10 ? 10
2 - For Alternative MAINTAINABILI any value between 0 and 10 ? 4
3 - For Alternative NETWORK any value between 0 and 10 ? 8
4 - For Alternative FAX any value between 0 and 10 ? 5

STEP 4 : INDIVIDUAL EVALUATION OF ALTERNATIVES
Method used : Direct input

A ALTERN. EVALUATION: WORKING AREA

	SYSTE	MAINT	NETWO	FAX
COST	5.00	3.00	7.00	8.00
USABI	8.00	4.00	9.00	6.00
REUSA	7.00	9.00	5.00	5.00
COMPA	6.00	10.00	7.00	3.00
EFFIC	10.00	4.00	8.00	5.00

B PRIORITY VECTOR

SYSTEM_INTRE	°0.370 °
NETWORK	°0.296 °
FAX	°0.185 °
MAINTAINABIL	°0.148 °

Do you want to modify the weights (Y/N) ?

SYS	NET	FAX	MAI
0.37	0.30	0.19	0.15

STEP 4 : INDIVIDUAL EVALUATION OF ALTERNATIVES
Method used : Direct input

FINAL SOLUTION

NET	SYS	FAX	MAI
0.29	0.27	0.23	0.22

Press any key to continue

STEP 4 : INDIVIDUAL EVALUATION OF ALTERNATIVES
Final Result

The following person(s) is (are) allowed to read your solution:

DM ONE
DM TWO
DM THREE

The following person(s) is (are) not allowed to read your solution:

Do you confirm the above lists (Y/N) ?

```
BILLET.DEF                                        DFAS2.GN
Q.DEF                                             POSEY.GN
MONDAY.DEF                                        SUV.GN
QQ.DEF                                            DREW.GN
DSSFINAL.DEF                                      WEEK.GN
MAINT.DEF                                         RALPH.GN
REMAP.DEF                                         REMAP.GN
CELLU_CO.DEF                                      CELLU_CO.GN
FINAL.DEF                                         CELL_COM.GN
HOLD_ON.DEF                                       HOLD_ON.GN
CELL_COM.DEF                                      FINAL.GN

THE NAME OF THE PROBLEM  ?   CELL_COMP_DESIGN

THE NAME OF THE NORM ?   CELL_COMP_DESIGN

YOUR NAME ?  DM FOUR

YOUR ID ?     ****


STEP 5 : DIRECT INPUT OF THE WEIGHTS
Identification of the problem
```

RAW INPUT

```
SYSTEM_IN:
MAINTAINA:
NETWORK  :
FAX      :
```

PRIORITY VECTOR

```
SYSTEM_IN °     °
MAINTAINA °     °
NETWORK   °     °
FAX       °     °
```

Enter the weights (0 - 10) of the ALTERNATIVES :

```
SYSTEM_INTREFACE          : 9
MAINTAINABILITY           : 6
NETWORK                   : 8
FAX                       : 4
```

STEP 5 : DIRECT INPUT OF ALTERNATIVES WEIGHTS

RAW INPUT	
SYSTEM_IN:	9.00
MAINTAINA:	6.00
NETWORK :	8.00
FAX :	4.00

PRIORITY VECTOR	
SYSTEM_IN °	0.333°
NETWORK °	0.296°
MAINTAINA °	0.222°
FAX °	0.148°

```
SYS  NET  MAI  FAX
0.33 0.30 0.22 0.15
 DO YOU WANT TO MODIFY THE EVALUATION OF THE ALTERNATIVES (Y/N)

 STEP 5 : DIRECT INPUT OF ALTERNATIVES WEIGHTS
```

FINAL SOLUTION

SYS	MAI	NET	FAX
0.33	0.22	0.30	0.15

Press any key to continue

STEP 5 : DIRECT INPUT OF THE WEIGHTS
Final Result

FINAL SOLUTION FOR GROUP EVALUATION:

Alternatives	Direct	DIrect/Direct
SYSTEM_INTREFACE	0.27	0.33
MAINTAINABILITY	0.22	0.22
NETWORK	0.29	0.30
FAX	0.23	0.15

(1) Sum of outranking relations
(2) Additive utility formula

Which Method do you want to choose? i

```
BILLET.DEF                                DFAS2.GN
Q.DEF                                     POSEY.GN
MONDAY.DEF                                SUV.GN
QQ.DEF                                    DREW.GN
DSSFINAL.DEF                              WEEK.GN
MAINT.DEF                                 RALPH.GN
REMAP.DEF                                 REMAP.GN
CELLU_CO.DEF                              CELLU_CO.GN
FINAL.DEF                                 CELL_COM.GN
HOLD_ON.DEF                               HOLD_ON.GN
CELL_COM.DEF                              FINAL.GN

THE NAME OF THE PROBLEM  ?   CELL_COMP_DESIGN

THE NAME OF THE NORM ?   CELL_COMP_DESIGN

YOUR NAME ?  DM ONE

YOUR ID ?    ****


STEP 6 : COMPUTATION OF GROUP DECISION
Files related to the problem
```

ALT.	CARDINAL RANKINGS			ORDINAL RANKING			GROUP RESULTS				
	DM O	DM T	DM T	DM O	DM T	DM T		R1	R2	R3	R4
Weig.:	1.00	1.00	1.00								
SYS	0.23	0.30	0.30	2	1	1	SYS	0.29	0.29	11.0	5.0
MAI	0.29	0.25	0.25	1	2	2	MAI	0.25	0.25	8.0	8.0
NET	0.23	0.24	0.24	2	3	3	NET	0.25	0.25	6.0	10.0
FAX	0.25	0.20	0.20	2	4	4	FAX	0.20	0.20	2.0	14.0

R1 : MAX. ADDITIVE RANKING
R2 : MAX. MULTIPLICATIVE RANKING
R3 : MAX. SUM OF OUTRANKING RELATIONS
R4 : MIN. SUM OF THE RANKS

Use , , , PgUp, PgDn, CtrltrlCtrl, Ctrl keys to move windows.
Press RETURN to continue

STEP 6 : COMPUTATION OF GROUP DECISION
All users contributed solution.

```
BILLET.DEF                                  DFAS2.GN
Q.DEF                                       POSEY.GN
MONDAY.DEF                                  SUV.GN
QQ.DEF                                      DREW.GN
DSSFINAL.DEF                                WEEK.GN
MAINT.DEF                                   RALPH.GN
REMAP.DEF                                   REMAP.GN
CELLU_CO.DEF                                CELLU_CO.GN
FINAL.DEF                                   CELL_COM.GN
HOLD_ON.DEF                                 HOLD_ON.GN
CELL_COM.DEF                                FINAL.GN

THE NAME OF THE PROBLEM  ?   CELL_COMP_DESIGN

THE NAME OF THE NORM ?   CELL_COMP_DESIGN

YOUR NAME ?  DM ONE

YOUR ID ?    ****


STEP 7 : COMPUTATION OF NAI
Files related to the problem
```

The NAI results of users: GROUP SOLUTION BY INTERSECTION

DM ONE				DM TWO				DM THRE				
Alt	Cadl	SiD,n	Ld,i	Alt	Cadl	SiD,n	Ld,i	Alt	Cadl	SiD,n	Ld,i	
MAI	0.29	--	1.20*	SYS	0.30	--	1.30*	SYS	0.30	--	1.30*	SYSTEM_INTREFA
FAX	0.25	0.58	1.06	MAI	0.25	0.60	1.13	MAI	0.25	0.60	1.13	MAINTAINABILIT
NET	0.23	0.39	1.02	NET	0.24	0.40	1.18	NET	0.24	0.40	1.18	NETWORK
SYS	0.23	0.29*	--	FAX	0.20	0.32*	--	FAX	0.20	0.32*	--	FAX

* Red colored Alternatives = Most Preferred Alternatives
* Black colored Alternatives = Preferred Alternatives
* Blue colored Alternatives = Negligible Alternatives

Use , , , PgUp, PgDn, Ctrltrl, Ctrl, Ctrl keys to move windows
Press RETURN to continue
STEP 7 : COMPUTATION OF NAI
All users contributed a solution.

Thank you for using Co - Op

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